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Horizontal Boring, Drilling and Milling Machine.

We illustrate herewith a new machine, which is designed to be set up in the erecting shop, and is intended to bore holes, face hubs, mill slots or spotting pieces, drill and tap holes for studs, etc. Every manufacturer knows how expensive this class of work generally is, as ordinarily performed, especially when the work is done on heavy castings.

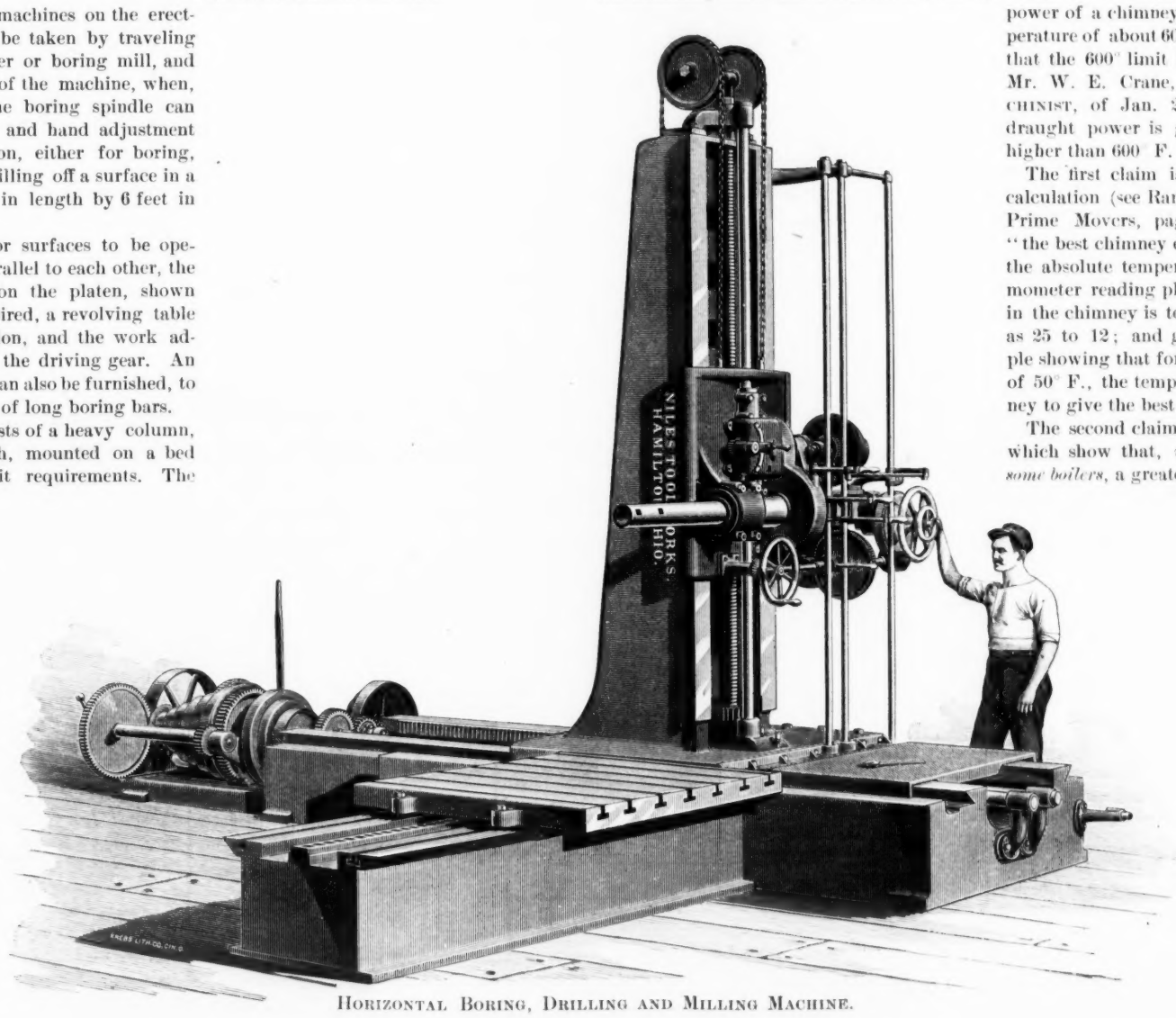
With one of these machines on the erecting floor, work may be taken by traveling cranes from the planer or boring mill, and placed on the platen of the machine, when, without re-setting, the boring spindle can be brought by power and hand adjustment to any desired position, either for boring, drilling, tapping or milling off a surface in a space 9 feet or more in length by 6 feet in height.

In case the holes or surfaces to be operated upon are not parallel to each other, the work can be re-set on the platen, shown in the cut; or, if desired, a revolving table is furnished in addition, and the work adjusted by power from the driving gear. An independent column can also be furnished, to support the outer end of long boring bars.

The machine consists of a heavy column, 10 feet 6 inches high, mounted on a bed of any length to suit requirements. The column is moved along the bed, to which it is firmly gibbed, by power operating through worm gear and rack. The column is 31 inches wide on the face, and is fitted with a heavy saddle 40 inches square, which carries the spindle. The saddle has a vertical traverse on the column of 6 feet, and is raised and lowered by a large screw, operated by power. It is balanced by a counterweight hung in the column.

The boring and milling spindle is hammered steel, 4½ inches in diameter. It slides in a heavy revolving sleeve, and has a traverse of 4 feet. It revolves in either direction, right or left hand, reversing by a lever conveniently located, and has eight power feeds, ranging from $\frac{1}{20}$ to $\frac{1}{4}$ of an inch per revolution of spindle. It is also provided with hand feed and quick return. The milling feeds are six in number, ranging from $\frac{1}{12}$ to $\frac{9}{16}$ of an inch per revolution of spindle. These feeds are applied only to the column and saddle, and are by power only. Any of these feeds for the quick motion may be utilized to set a drill, boring bar, tap or milling cutter to work anywhere on the surface reached by the machine. At one end of the bed is placed the driving gear, milling feed and quick traversing mechanism for the column and saddle. The quick power traverse of the column has a speed of 5 feet per minute.

The driving cone has six steps for a 4-inch belt, and is strongly back-geared, giving twelve changes of speed, which range from 2 to 200 revolutions per minute, and give ample power for boring up to 24 inches diameter. A platen is placed in front of the column, convenient to the spindle, for the operator to stand on, and all movements of the spindle, saddle and column, may be started, stopped, or reversed by levers conveniently arranged on and traveling with the column, within easy reach of the operator while he watches the work.



HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

Similar machines have for a long time been held in the highest esteem in English shops, and are gradually coming into favor in this country. Wherever they have been installed they have proved to be a very profitable investment. The saving effected in the cost of handling alone is found to pay a handsome interest on the cost, to say nothing of the accuracy and ease of work performed.

The builders are the Niles Tool Works, Hamilton, Ohio.

An enterprising firm of this city, Watson & Stillman, finding that some of their machinists working near the large double doors on the Forty-third street side of their shop were constantly catching colds, if not the grippe, have invested $15 in a canvas vestibule, which gives great satisfaction. Four heavy canvas curtains, hung on iron rods, and operated by small ropes, after the manner of awnings, are arranged so as, when dropped down, to enclose a space about ten or twelve feet square, just inside the big folding doors. Then, when a heavy piece of machinery is to be loaded or unloaded, these doors can be open without every machinist employed on tools located in that part of the shop being exposed to a fierce draught of cold air or young tornado of wind.

Hooks and eyes make the four curtains substantially close with a moment's work, or the curtains can be tied up separately when not required for use, with very little trouble.

Unlike a fixed or wooden enclosure, they practically occupy no room in the shop, while, if anybody or thing bumps into them, there is no harm done.

Jersey City—right across the river from New York—does not seem to profit by the experience of the latter city in regard to electric wires. While New York has found it necessary to the safety of its inhabitants to relegate the electric wires to a position underground, Jersey City goes right on dispensing franchises to new corporations to string them overhead, all of which shows how little cities as well as individuals learn by the experience of others.

The total number of personal accidents which occurred on the Belgium State railways in 1888 was 745, against 555 in 1887. Of the 745 accidents, 118 proved fatal. On the other railways the personal accidents numbered 107, of which 34 resulted in death. The total length of the State railways is 6,338,006 meters, and of the other railways 2,151,501 meters.

Temperature and Chimney Draught.

BY WILLIAM KENT.

One set of men claim that the draught power of a chimney is a maximum at a temperature of about 600° F. Another set claim that the 600° limit is a fallacy (for example, Mr. W. E. Crane, in the AMERICAN MACHINIST, of Jan. 23, 1890), and that the draught power is greater at a temperature higher than 600° F.

The first claim is based on a theoretical calculation (see Rankine's Steam Engine and Prime Movers, page 289). Rankine says, "the best chimney draught takes place when the absolute temperature [that is, the thermometer reading plus 461.2° F.] of the gas in the chimney is to that of the external air as 25 to 12; and gives a numerical example showing that for an external temperature of 50° F., the temperature within the chimney to give the best draught is 603.8° F.

The second claim is based on observations which show that, *with some chimneys and some boilers*, a greater amount of coal can be burned on the grate of the boiler when the temperature is much higher than 600° than when it is 600°.

At first sight there appears to be an irreconcilable difference between theory and practice, but I think it can be shown that the apparent difference may be reconciled.

Rankine is the engineering student's terror. The professors hold him up to our admiration, and swear by him, but the student, struggling with his concise, rigid and exact mathematical demonstrations, is apt to discover fallacies in his reasoning, and to suspect that he may be wrong. But, after finally mastering the subject, as Rankine mastered it, the student becomes as great an admirer as the professor is, and therefore holds as a dogma in his engineering creed, "*Rankine is hard to understand, but when you understand him, he is always right.*"

Approaching the difficult study of chemical draught with this belief in Rankine, yet by no means disputing the observed facts given by Mr. Crane, let us see where the trouble lies.

What is meant by the draught power of a chimney?

Rankine uses the following words. "The most effective draught, that is, the maximum *weight* of hot gas discharged per second." He then means by draught power of a chimney, its *capacity for discharging gas*, and he measures the gas by weight, be-

cause weight is constant, while volume or cubic measure of gas varies with its temperature.

Mr. Crane says: "The amount of coal burned per square foot of grate [under the boilers], when the melting furnaces were not running, was about 15 pounds. When the melting furnaces were running [by which the chimney was heated to a very high temperature] the amount that could be burned was over 25 pounds." That means that, when the chimney was very hot, it exerted a pull on the boiler furnace, that is, produced such a partial vacuum in the boiler furnace that enough air rushed through the grate bars, and through the coal above them, to cause 25 pounds per square foot per hour to be burned, while, when the chimney was only moderately hot, say 600°, the pull was sufficient only to cause 15 pounds to be burned per square foot of grate per hour.

Mr. Crane then means by draught power, the amount of pull, reduction of pressure or partial vacuum produced in the boiler furnace. One way of indicating this "pull," is by noting the amount of coal burned per square foot of grate. A way of measuring it directly is by a draught gauge, a **U** shaped glass tube, with a little water in it, one leg connected by a pipe to the inside of the furnace, and the other to the external atmosphere, noting the difference in level, in tenths of an inch, in the water in the two legs of the tube.

To repeat, Rankine means by draught power of a chimney, its capacity to discharge gas. Mr. Crane means the strength of its pull on the furnace.

Both definitions are in common use. We cannot say either is wrong. It is only an instance of the defect of the English language, which allows one term to be used in two different senses (for a similar instance see the word "force" as used by Prof. Wood, and by Pedro, in the same issue of the AMERICAN MACHINIST, Jan. 23, 1890.)

A chimney "draws," because the external air is heavier than the hot gas in the chimney. The hotter the gas in the chimney the lighter it is, the greater is the difference between the weight of a column of it and the weight of a similar column of cold air outside, the greater is the "force" or "push," which is the difference between the weight of the cold air and the weight of the hot gas, the greater is the velocity of the hot gas in the chimney, and the greater is the draught power (using Mr. Crane's definition) as shown by a draught gauge.

Rankine's formula for velocity of chimney current (page 286) shows that the velocity increases as the temperature of the hot gas increases.

Suppose we have a chimney designed for 500 horse-power of boilers, and have attached to it only one 100 horse-power boiler. Suppose the heating surface of the boiler, and the amount of coal burned under it, have such relations to each other that the gases of combustion escape into the chimney at a little over 600° F., and that, under these conditions, 15 pounds of coal are burned per square foot of grate. The amount of coal which can be burned on the grate is limited by the amount of air which is pulled through the grate and through the bed of coal. The amount of air which can be pulled through the coal is limited by several different conditions, such as area of opening of ash-pit door, area between grate bars, air passage or intersections between the particles of coal, depth of the bed of coal, area of passages for the gas through flues or tubes, number of bends or turns in these passages, area of damper opening, and finally by the difference in pressure between the outside atmosphere and the gas in the chimney. The area and height of the chimney in this case do not limit the amount of coal that can be burned, for we have assumed the chimney to be large enough for five times the number of boilers that are attached to it.

The last of the limits above mentioned is the difference of pressure inside and outside of the chimney, and this, as we have seen, depends upon the temperature of the gases in the chimney. If we can increase this temperature, we will make lighter the column of gas in the chimney, the chimney will draw or pull harder, and if the other conditions, such as area of tubes, depth of coal, area of grate bar openings, etc., remain the same, more coal will be burned on the grate.

In ordinary boiler practice it is difficult to change the one condition of the temperature of the gas in the chimney, without changing some other condition; but Mr. Crane's example, shows how it may sometimes be done. In his case, having a chimney larger than is required for the boilers, he attaches to it a melting furnace, which discharges gas of a very high temperature. The chimney having plenty of area for the extra quantity of gas delivered by the melting furnace, the increase of temperature makes the column of gas lighter, the chimney draws harder on the boiler, and more coal is burned under it.

In our supposed case, let four other boilers be attached to one chimney, each one discharging gas into it at the same temperature, a little over 600° F. The drawing power of the chimney, as shown by the draught gauge, remains the same, but we have now introduced another limit to the amount of coal which can be burned, namely, the area of the chimney itself. The five boilers using a certain amount of coal discharge a quantity of gas, which, with a given velocity of travel, requires a certain area of chimney to discharge it. The velocity being limited by the temperature, and by the height of the chimney, a chimney of a given area will discharge a certain quantity, but no more. The chimney itself now being the limit to the quantity of coal which can be burned, we now reach the question treated of by Rankine, at what temperature of the gases inside will the chimney discharge the greatest quantity of gas?

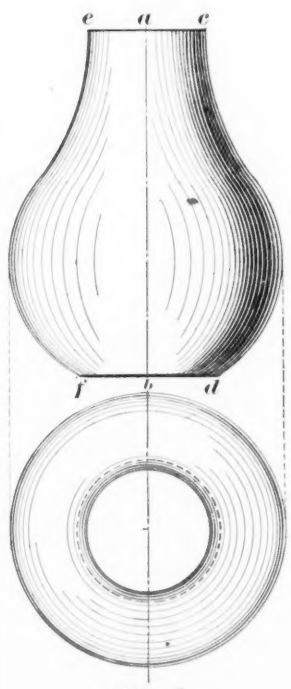


Fig. 1

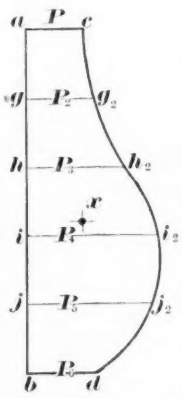


Fig. 2

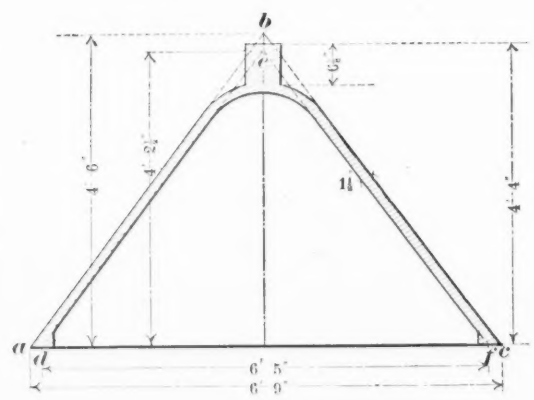


Fig. 4

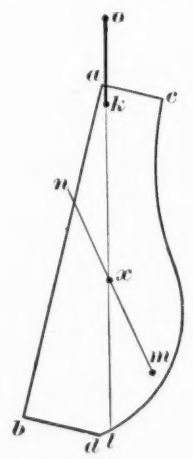


Fig. 3

WEIGHT OF SOLIDS.

As already seen, the higher the temperature, the greater the velocity of the gas, but we now have a new element to consider—the *change of volume* of the chimney gas with its change of temperature. As the temperature increases, the gas gets lighter. A pound of it occupies a greater space. A chimney full of gas at a high temperature contains less gas than the same chimney full at a lower temperature. To burn a pound of coal, we need about twenty-four pounds of air. The gases of combustion will weigh twenty-five pounds. The space they occupy will be greater, the higher their temperature, and if they moved at the same velocity, they would need a larger chimney to discharge them. But they move faster when their temperature is increased.

So we have two conditions in opposition to each other. If we increase the temperature of the gases in our 500 horse-power chimney, we cause them to travel faster; but as we increase the temperature we also expand their bulk, and thus give the chimney a greater volume to discharge. If the increase in velocity were exactly the same as the increase in bulk, the chimney would discharge the same weight of gas at any temperature, but the expansion of the bulk, and the increase of the velocity, do not follow the same law. By the mathematical treatment given by Rankine, it is shown that the product of bulk and velocity is a maximum when the temperature is a little over 600° F.

Below 600° F., an increase of temperature causes an increase of velocity at a greater rate than the increase of bulk, so that, the higher the temperature, the greater the weight of gases discharged; but above that temperature the gases expand faster than they increase in velocity, and therefore the higher the temperature above 600° F., the less the quantity of gas will be discharged. So that if our 500 horse-power chimney is to do the utmost work of which it is capable—that is, cause the burning of the largest quantity of coal under a battery of 5 or 6 hundred horse-power boilers—it will do the most work when the temperature of the gases is about 600° F. In this case the chimney itself is the limiting element, and the area of dampers, flues, grate bars, etc., are supposed to be ample. But if the limit is in the boilers, and not in the chimney, the chimney being abundantly large, then the more coal will be burned under the limited boilers, the higher the temperature of the chimney gases.

Rankine's mathematical treatment of the subject has been attacked, but it has not been overthrown. It is entirely correct, when the chimney itself is under consideration, but it has been misunderstood by writers who have not made the clear distinction between the two common meanings of the words "draught power," which has been given above.

Weight of Solids.

Problems relating to the computation of the weight of bodies similar in form to those shown in our illustrations can be easily solved, although at first sight their solution may appear to be difficult. Let it be required to find the weight of a solid similar in form to that shown in Fig. 1.

Our first step will be to find its solidity or its volume in square inches, and, when this has been found, we simply multiply the volume by the weight of one square inch of the material; the product will be the weight of the solid. In fact, this is the general mode of procedure in finding the weight of any solid, no matter what its shape may be. But our aim is to find the weight of the particular class of solids here shown, hence we will first confine our attention to method of finding these volumes.

Let Fig. 2 represent a half section of the solid, or that plane figure which, in revolving round the line $a\ b$ as an axis, would require a space equal and similar to the given solid, or, as it is commonly expressed, would generate the solid. Hence we say that Fig. 1 represents a *solid of revolution*. The volume of any solid of revolution, however complex or irregular its outline may be, can be found by the following very simple method:

Find the center of gravity x of the half section (Fig. 2), and multiply the path or circumference which it describes during one revolution of the plane around the axis $a\ b$ by the area in square inches of the half section; the product will be the volume required. The circumference which the center of gravity will describe is found by multiplying the well-known constant 3.1416 by twice the distance of the center of gravity x from the axis $a\ b$.

Here the questions may arise, How can we find the center of gravity of the half section? And how can we find the area of the same section?

The center of gravity can be found by the following method: Cut the half section $a\ b\ c\ d$ out of some substance of uniform thickness—stiff drawing paper will answer the purpose—and suspend it by means of a fine thread $o\ k$ from any point k in its surface, as shown in Fig. 3; when the paper figure is at rest, draw from k a vertical line $k\ l$, that is to say, a line having the same direction as the thread $o\ k$. In a similar way suspend the paper figure from any other point, m for instance, and from this point draw the vertical line $m\ n$, intersecting the line $k\ l$ in the point x, which will be the center of gravity of the surface $a\ b\ c\ d$.

To find the area of the half section $a\ b\ c\ d$, divide the line $a\ b$ into any number of equal parts, and through the points of division g, h, etc., draw lines perpendicular to $a\ b$, terminating in the curve $c\ d$. Then to one-half of the lengths of the outer lines $a\ c$ and $b\ d$, add the lengths of lines or ordinates $g\ g_2$, $h\ h_2$, $i\ i_2$, $j\ j_2$, and multiply the sum by the length $a\ g$ or $g\ h$, or, in other words, multiply by the distance between any two successive ordinates; the product will be the area. Or in symbols we have $(\frac{1}{2}P + P_2 + P_3 + P_4 + P_5 + \frac{1}{2}P_6) \times S =$ area, in which P_1, P_2, P_3, etc., are respectively the lengths of the lines $a\ c$, $g\ g_2$, $h\ h_2$, etc., and S the distance between any two successive ordinates. To illustrate, let $a\ b$ be 2 feet $8\frac{1}{2}$ inches long, $P = 6$, $P_2 = 6\frac{1}{2}$, $P_3 = 9$, $P_4 = 12\frac{1}{2}$, $P_5 = 12$ and $P = 7\frac{1}{2}$ inches. Under these conditions the distance between any two successive ordinates will be

$$\frac{2'\ 8\frac{1}{2}''}{5} = 6\tfrac{1}{2} \text{ inches.}$$

Hence we have

$$\left(\frac{6}{2} + 6.5 + 9 + 12.5 + 12 + \frac{7.5}{2}\right) \times 6.5 = 303.875 \text{ square inches}$$

for the area of Fig. 2. This will give us only an approximate result, but the greater the number of parts into which the line $a\ b$ is divided, the more correct will be the result, and can be made sufficiently close for practical purposes. Of course there are other methods for finding this area, but the one here given is well adapted for finding the area of this particular section.

Suppose now we have found by measurement that the distance from the center of gravity to the line $a\ b$ is $3\frac{1}{4}$ inches, the circumference which it will describe in moving around $a\ b$ as an axis will be

$$3.1416 \times 2 \times 3.25 = 20.42 \text{ inches.}$$

Multiplying this circumference by the area of Fig. 2, we have $20.42 \times 303.875 = 6{,}205.12$ cubic inches, which is the volume

of the solid of revolution shown in Fig. 1. We now multiply this volume by the weight of the material per cubic inch. If, for instance, our solid is made of cast-iron, and assuming that one cubic inch weighs .26 of a pound, then the weight of the solid will be $6,205.12 \times .26 = 1,613.33 +$ ponnds.

A cupola bell, such as is shown in Fig. 4, is also a solid of revolution, hence its weight can be found in a similar way; but in cases of this kind a more approximate method, involving less labor, will often answer all practical purposes. For instance, here we should prolong the outer and inner sides of the bell to meet in the points b and e respectively, then find the volume of the outer cone $a\ b\ c$, also that of the inner cone $d\ e\ f$, and subtract the volume of the latter from that of the former; the remainder will give us the required volume of the bell, with the exception of the extra thickness of the bottom, for which an allowance must be made. For instance, the altitude of the outer cone is 4 feet 6 inches, and the base 6 feet 9 inches diameter. To find the volume of this cone we apply the well-known rule, namely, the volume of a cone is equal to one-third the product of its base and altitude. The area of the base is 5,153 square inches, hence its volume is

$$\frac{5,153 \times 54}{3} = 92,754 \text{ cubic inches.}$$

The altitude of the inner cone is 4 feet 2½ inches, and the area of its base is 4,656.6 square inches, hence its volume is

$$\frac{4,656.6 \times 50.5}{3} = 78,386.1.$$

Subtracing this volume from the former one, we have

92,754 — 78,386.1 = 14,367.9 cubic inches.

Assuming that one cubic inch of cast-iron weighs .26 of a pound, we have

$14,367.9 \times .26 = 3,735.6$ pounds.

Adding about 70 pounds for the extra thickness at the bottom, we have 3,805 pounds for the bell. The weight of this extra thickness can be found by multiplying its cross-sectional area by the circumference which its center of gravity will describe.

Force in the Steam Engine and its Relation to Smooth Running.

BY PROFESSOR JOSEPH TORREY.

SEVENTEENTH PAPER.

In the last paper the general method was given of securing a nearly perfect balance in the horizontal direction (in case of a horizontal engine). In that, as well as in all other cases to be described, the mistake must not be made of confusing *balancing* effect with *weight*. For instance, in order to balance an engine in the horizontal direction, we say the counterweight must equal *in effect* the disturbing effect of all the reciprocating parts; but it does not necessarily follow that the weight of the counterbalance must just equal that of the reciprocating parts. It may in some cases, but it depends on the shape of the counterweight mostly. The method of determining the weight of metal to be cast on as counterbalance will be given later, and is alluded to here to avoid misunderstanding.

We will now consider the case where balance in the vertical direction is sought. In this case the disturbing elements are first the crank and pin, and, second, the large end and some more of the connecting rod. The best way will be to first find the portion of the connecting rod which is centrifugal in effect, as described in a former paper, then find the disturbing effect (*at the radius of the crank*) produced by this weight with the crank and pin. These are, of course, to be considered as simply exerting their centrifugal force up or down at the top and bottom quarter respectively. Knowing the amount of this centrifugal disturbance, it is only necessary to introduce a counterweight which will exert an equal force in the opposite direction. The exactness of balance obtainable here will depend on the care taken in ascertaining the amount of disturbing force. It is an easy matter to get it exact enough for all practical purposes. In this case, also, the particular method of proceeding will be given later. Just now we are getting at the principle.

Notice next that the counterweight we have proportioned to balance simply the crank, crank-pin, and centrifugally acting part of the connecting rod, has also partially balanced the reciprocating motion of the other parts, and if we begin adding to our counterweight we shall do two things. First, we shall begin to overbalance vertically; that is, there will be unbalanced vertical force, due to the counterweight generating more centrifugal force than crank, pin, etc. Second, we shall gradually balance more and more of the horizontal vibration as the effect of our counterweight builds up. So the vertical disturbance will increase and the horizontal decrease. Any one who has followed

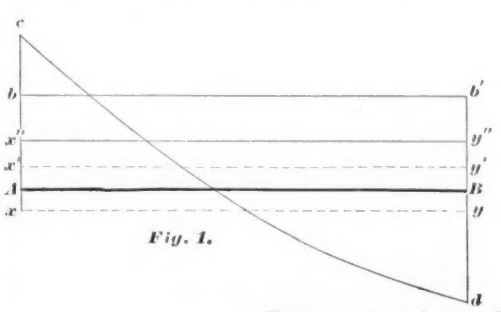


Fig. 1.

FORCE IN THE STEAM ENGINE.

what has been said up to this point will easily see that there must come a point where the vertical overbalance and the horizontal lack of balance are very nearly equal. In some cases, as we shall see, this is the proper counterweight, as it effects a compromise between excessive horizontal and vertical vibration or strain.

This matter can be studied very satisfactorily by a diagram. In Fig. 1 let $A\ B$ equal the length of stroke; then on this as neutral line construct the inertia curve $c\ d$ for the engine under consideration. Let us now start with no balance attempted at all, and see what is the state of things

In the first place, the diagram shows clearly that the disturbance at ends of the stroke are simply due to inertia. To see how the vertical balance is, find the amount of disturbance due to the crank-pin, and part of the rod in pounds, and lay it off by scale below $A\ B$ on $c\ c'$. Then, since this disturbing force is constant throughout the stroke, we draw a horizontal line $x\ y$, and the distance $A\ x$ by scale gives the amount of vertical disturbance.

Now suppose a counterweight be proportioned which will just balance this vertical disturbance, and the result can be seen by laying off $A\ x'$ *above* $A\ B$ equal to $A\ x$, and drawing $x'\ y'$ parallel to $A\ B$. Now we see that the vertical forces are exactly balanced, as shown by the equal amounts above and below $A\ B$, but it also appears that this slight counterweight has also neutralized part of the horizontal inertia force $A\ c$, and $x'\ c$ represents the amount remaining unbalanced horizontally.

Let us now just double our counterweight. The effect will be seen by drawing another horizontal line above $x'\ y'$, making $x'\ x'' = A\ x'$. Now $x'\ x''$ represents overbalance in the vertical direction, and $x''\ C$ underbalance in the horizontal direction. Now if we wish to find the necessary counterweight to make the vertical overbalance and horizontal underbalance equal, we have only to find the middle point of the line $x'\ C$, and draw at this point a horizontal line $b\ b'$ as shown. Then measuring $A\ b$ by scale gives the centrifugal force in pounds which our counterweight must exert in order to equalize the horizontal and vertical effect. Knowing the centrifugal force required, the weight which, acting at the radius of the crank, would generate it, is easily found by the formula

$$W = \frac{F}{.000341\ R\ n^2}$$

where W = weight required.
F = centrifugal force in pounds.
R = radius of crank in feet.
n = revolutions per minute.

Whether this is the actual counterweight to be used depends on the shape in which it is to be cast; and, now that we have gone over the principles, we will consider the actual application of counterbalance to engines.

In order to have the best theoretical effect, the counterweight ought to be directly in the line of centers; that is, a straight line passing through the center of the cylinder ought to pass through the center of the counterweight at the ends of the stroke. Of course that is impossible, and in practice we are obliged to apply the counterweight in one of four ways. 1. By casting it on as a part of the crank. This is done only in small engines to any extent. 2. By employing a disk crank, and casting the counterweight on the disk. 3. In center crank engines, by using a double crank disk and dividing the counterweight between the two disks; and 4. By applying the counterweight to the driving pulleys. This last method is used in case of locomotives, on small engines to some extent, and on large low-speed engines for the sake of a standing balance, mostly. The first three methods will be the only ones we shall consider.

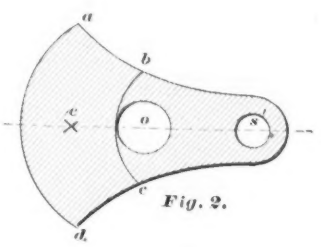


Fig. 2.

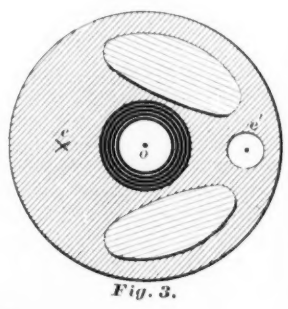


Fig. 3.

When the counterbalance is cast on the crank it is usually as a fan-shaped extension, as shown in Fig. 2. To find the weight of such a counterbalance, the amount of balancing to be attempted having been decided on, find the centrifugal force which must be developed (according to the methods previously explained), and by means of the formula just given find the weight which would be required at the radius of the crank. Then cut out from thin board or sheet metal a templet full size of your counterbalance $a\ b\ c\ d$. Find its center of gravity by balancing it on a fine point, and measure the distance of this center of gravity from the center of the shaft. If the center of gravity is nearer the center of the shaft than the center of the crank-pin is, the counterbalance will have to be heavier than it would if it were at the radius of the crank; but if $o\ e$ is greater than $o\ e'$ then the counterweight will have to be *lighter* and just in proportion as it is farther away. The reason for this is simply that the centrifugal force increases as the radius.

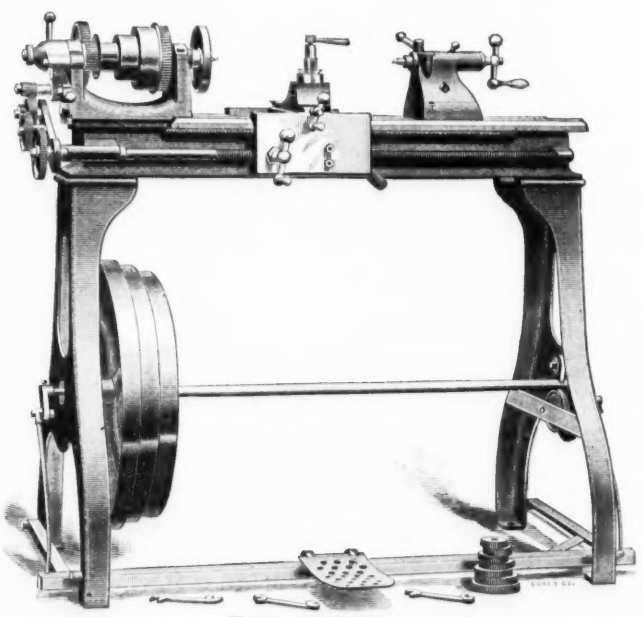
Having measured the distance from the center of the shaft to the center of gravity of the templet, find the actual weight of metal needed by the proportion

$$o\ e\ :\ o\ e'\ ::\ x\ :\ w$$

$$\text{whence } x = \frac{w\ x\ o\ e}{o\ e'}$$

That is, multiply the weight which would be needed at the radius of the crank by the distance from center of shaft to center of gravity of templet. Divide by the radius of the crank, and the result will be the weight of the counterbalance in pounds. The next thing is to find the thickness of the counterweight. First we find what its volume will be in cubic inches, as follows: A cubic inch of cast-iron weighs about 0.26 pounds. Hence, dividing the weight by 0.26 gives the volume in cubic inches. Then find the area of your templet, which can be done accurately enough by dividing it and measuring the divisions. Divide the volume of the counterweight by the area of the templet in inches, and the result will be the thickness of the counterweight. If the thickness is too great, change the shape of your templet so as to increase the area a little. Generally one or two trials will give a satisfactory shape. Another good way to get at the area of your templet, is to saw off a square or oblong piece of board, find its area, and weigh it. Then mark out your templet on it, saw it out, and weigh it; then say weight board : area board :: weight templet : area templet; or multiply area of board by weight of templet. Divide product by weight of board, and result will be area of templet. The method just given applies in case of a counterbalance which is cast on a crank disk single or double (see Fig. 3), and the same calculations and measurements are made. In case of a double-crank disk, figure the whole counterweight, and then divide the thickness found by 2. This will give the thickness to cast on each of the two disks.

We will next consider how we can decide as to how much balancing is necessary, and afterwards return to this part of our subject, and the necessary counterweights for engines enough to make at least the mechanical part clear.



TEN-INCH LATHE.

Ten-inch Lathe.

This lathe is one recently brought out by the Sebastian-May Co., Cincinnati, Ohio.

The sizes of cone pulleys are 2¼, 4, and 5½ inches diameter for 1½ inch belt. The front bearing of spindle is $1\frac{5}{16}$ inch in diameter, and 2¼ inches long; there is a half-inch hole through the spindle. Threads are cut by reversing a gear in the head-stock. The carriage is gibbed front and back. The fly-wheel of the foot motion weighs 85 pounds and is so balanced that it will not stop on the center. When required the lathe is furnished with countershaft to drive by power.

Brake Tests of Small Motors.

BY W. H. BOOTH.

The testing of a small motor by means of a brake, so as to determine its brake horse-power as distinguished from the power registered by an indicator, is not a difficult matter.

The appliances necessary are a piece of belting three to four inches in width, a smooth-faced fly-wheel on the crankshaft, and a scale pan or collection of weights. The leather belt requires to be free from stickiness, and in that well-known dry condition which makes it fairly easy to slip. The brake is arranged as shown in Fig. 1, the rim of the brake-wheel extending a little on each side of the belt. The belt has riveted across it, at intervals, light brass clips which serve to prevent the belt from slipping over the side of the rim; one end of the belt is brought, as shown, under the wheel, and attached to the floor; the other end carries a scale pan or a box for weights. When the motor to be tested revolves at its proper speed, weights are added at W until the safety rope c becomes slack. The motor is then doing work which is measured by the product of the weight into the circumferential speed of the wheel rim. This is the work done, but subject to a possible correction due to the tension upon the end a of the belt. This tension needs subtracting from the weight W in order to get the true value of the pull on the wheel rim.

It may be measured, of course, by a spring balance, but it is well, if possible, to eliminate this end pull entirely. To do this when it is present requires that the belt be scraped on its surface of contact. Scraping the leather increases its grip upon the wheel, and the piece of rope at a will thus be brought slack, and the weight W may be added to the amount of the eliminated pull. When by simply weighing W the exact brake horse-power may be found exactly as $\frac{W \times V}{33{,}000}$ when W is in pounds, and V is the velocity of rotation of rim in feet per minute. A 3-inch leather belt will test about 3 horse-power on a 6-foot pulley at 80 to 100 revolutions. If the belt has too powerful a grip, a little powdered chalk will reduce it; but to increase the grip no grease or composition must be used, or the action will be irregular and unsatisfactory.

As an example, suppose a gas engine with two fly-wheels of 5 feet circumference at 80 revolutions per minute, weights of 70 and 60 pounds, are found necessary to effect a balance.

Then the horse-power becomes

$(70 + 60) \times (5 \times \frac{22}{7} \times 80) \div 33{,}000 =$ brake horse-power.

Working out we have

$$130 \times 80 \times 15.7 = 163{,}280,$$

and $163{,}280 \div 33{,}000 =$ very nearly 5 horse power.

A common rope may be used in the same way, but for small powers the belt is easier of application, and seems to afford better facilities for entirely eliminating the counter pull. It is far more accurate to do this than to rely on the subtraction of an amount of pull as read off on a spring balance, and the increase of grip of a belt brought about by scraping its contact surface effectually secures the desired end.

The warmth generated by the absorption of 3 horse-power by one belt is only very slight, and is easily kept so by the radiation from the wheel rim. It will be interesting to calculate the rise in temperature of a wheel rim in one minute due to the absorption of 3 horse-power. Take the case in point. A wheel 4 inches on the face, 5 inches depth of rim, and a circumference of say 5 yards. The weight of such a rim will be 200 pounds per yard, or a total of 1,000 pounds.

Three horse-power = 99,000 foot-pounds per minute.

One unit of heat is 772 foot-pounds.

Thus $\frac{99{,}000}{772} = 128$ units of heat per minute to be absorbed. This is equivalent to raising the temperature of 128 pounds of water through 1 degree. Iron is stated to have a specific heat of .12. (Some give to cast-iron a specific heat of .24.) Then $128^\circ \div .12 = 1{,}066$, and this shows that the heat generated is sufficient to raise 1,066 pounds of iron through one degree. This is so nearly the weight of the rim that we can say at once it will only require to cool through one degree per minute in order to dissipate all the heat formed.

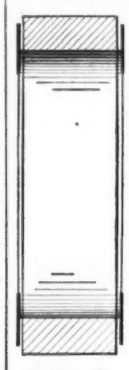


Fig. 2

A convenient brake is formed by using a pair of ropes,

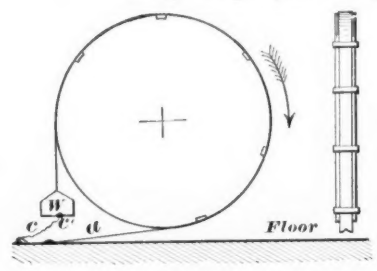


Fig. 1
BRAKE TESTS.

kept an even distance apart by means of cross-pieces of wood, the whole not unlike a rope ladder, if hung out straight, with wooden staves. Where the power of the motor is too great for the wheel rim to dissipate the heat generated, the wheel rim has been converted into a water channel, as shown in section in Fig. 2. The water remains in the channel by virtue of the centrifugal action of rotation, and evaporating by the absorption of heat from the rim; this is kept down to a safe temperature, use being here made of the enormous absorption of heat which takes place in the conversion of water to vapor. A brake of this nature was used recently in the small motor tests made by the Society of Arts at South Kensington in the year 1888, and it was found thoroughly satisfactory. With a thin, wide fly-wheel rim it is clear that the temperature can never much exceed that of boiling water.

The advantage of a direct weight brake, as compared with a lever brake, comes in, of course, in the avoidance of the causes of error introduced by a lever with its pivot friction, if any, and want of perfect horizontality of lever arm as measured. With the strap or rope brake the only measurements need be the wheel diameter, and the weight hung upon the strap. A comparison of the ease with which a fly-wheel can be cooled off when absorbing, as heat, all the useful work of a steam engine, with the heat of the boiler furnace, which would soon make the same fly-wheel red hot, is enough to convince one of the exceedingly small proportion of the fuel utilized by an engine. The difference presents itself so obviously on the one hand —a hot boiler pouring out steam at one pipe and smoke at another; on the other hand, a fly-wheel gently throwing off a small amount of steam, or even scarcely too warm to handle.

The conversion of heat into work is still only in its infancy. There must be some more direct and simple way to go about it.

A Jig That Centers its Work.

Any one who has had much to do with jigs knows the difficulty often met with on account of variations in size of castings, this trouble being especially annoying where some part, or perhaps all the outer surfaces are left unfinished. Where two or more castings of similar shape are placed together to form the completed machine, all the variation in size is thrown over on one side, where the jigs are constructed in the ordinary manner, because there are usually some fixed points in the jig, against which all the castings come when drilled, so that, when placed together, they will, of course, match at these points, but will usually be very uneven at all other points, all the variations in the size of castings being thrown over on that side where the screws, clamps, or other fastenings are applied to them in the jig. To make all the points of the jig separately adjustable is impracticable, for well-understood reasons, and it thus often happens that castings have to be tooled off on one side to make them match evenly, when it would not be necessary if it were not for considerable variation in size, or if that variation could be evenly divided between the sides, instead of being thrown entirely over to one side. To accomplish this latter object, the jig shown by the accompanying engravings was designed by Mr. James Brady, manager of the Brady Mfg. Co., Brooklyn, N. Y., who has been granted a patent on its novel features.

Mr. Brady manufactures, among other things, a check punch, the frame of which is of the shape and dimensions shown by Fig. 1. Two castings of similar shape are placed one on top of the other in the finished machine, and, as the outer surfaces are japanned, it is only necessary to get them to match well, and no finishing is needed. It was found, however, that if the unavoidable variations in size of castings could not be equally divided between the sides, finishing would be necessary.

Fig. 2 is a plan view of the jig for drilling this casting, its position in the jig being indicated by the dotted outline, while Fig. 3 is an end view.

The plate a, which is the frame of the jig, stands upon four legs $l\ l\ l'\ l'$ made of hardened steel, and which pass entirely through the plate, so as to form legs on both sides. The drawings show the jig turned over for putting work into it, the drilling being done from the other side. The two legs $l'\ l'$ also

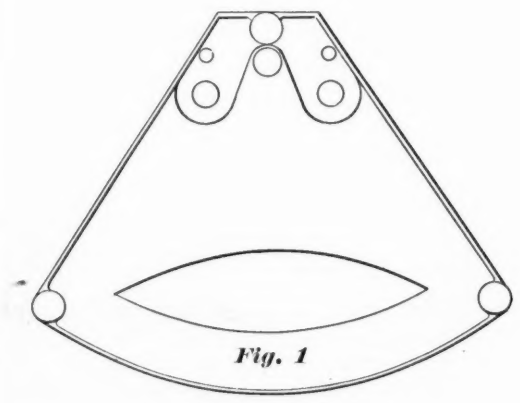


Fig. 1

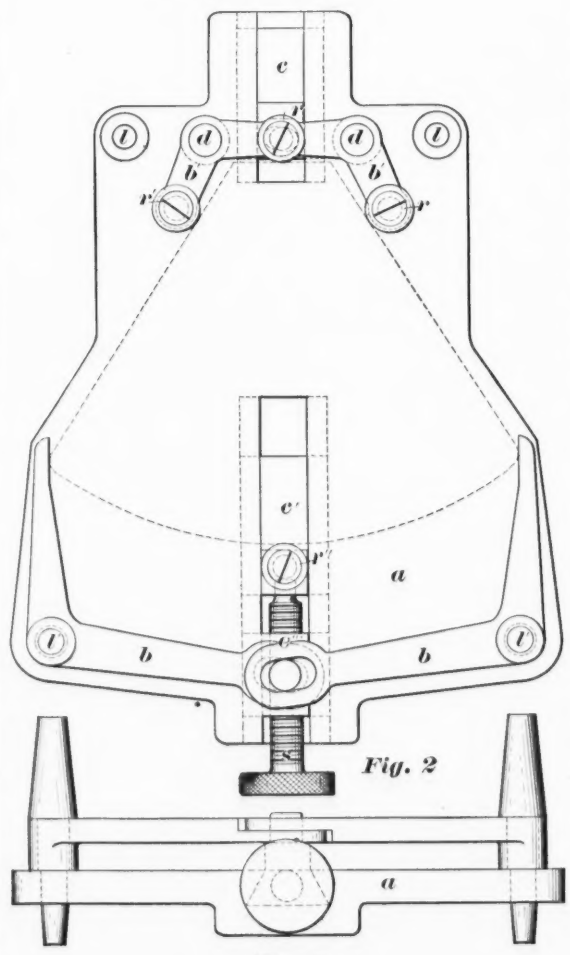


Fig. 2

Fig. 3
SELF-CENTERING JIG.

serve as studs, upon which the levers $b\ b$ are pivoted. At each end of the plate there is a dovetailed groove, in which blocks of steel are fitted to slide freely back and forth. Attached to the block c by a stud is a hardened steel roller r, this stud also passing through the ends of the levers $b'\ b'$, which are slotted to allow of movement. These levers are pivoted at the points $d\ d$, and at their other extremities carry hardened steel rollers. These three rollers come into contact with the work as shown, and center it; any movement of the roller r, causing a uniform movement of the two rollers $r'\ r'$. A ltttle consideration will show that none of these rollers will come to rest when the casting is forced against them until all have a bearing, and that, when this occurs, the two rollers $r'\ r'$, having a uniform motion, must be at equal distances from the center line, and the casting, therefore, centered at that end.

In the dovetailed slot at the other end of the plate are fitted two sliding blocks c' and c''. The screw s passes though c'', which is tapped to fit it, and has a bearing in the block c', being held in this bearing by a pin, passing through a groove turned in the end of the screw. The block c' carries a roller which comes in contact with the work, as shown, and to a stud in c'' are attached the ends of the levers $b\ b$, which are slotted, to allow of motion. Neither of these blocks is fixed stationary in the slot; but by taking hold of the screw, it and the blocks can be moved freely back and forth when no casting is in the jig; of course any movement of block c'' causing a lateral movement of the other extremities of the levers $b\ b$.

The effect of turning the screw is simply to separate or to draw the two blocks together according to the direction of the turning, the block which moves being the one which happens to meet with least resistance. Supposing the casting to be placed in the jig, and the screw turned, the block c' may be supposed to advance, pushing the casting before it until it comes in contact with the rollers at the other end, which center it there, as already explained. As soon as this is accomplished the block c' and its roller can advance no further, and consequently, by the continued motion of the screw, the block c'' is forced back, carrying the ends of the levers $b\ b$ with it, until their other extremities are both in contact with casting, and, as these extremities must always move together, keeping at equal distances from the center, the block c'' continues to move until both levers come to a bearing, and the casting is centered at that end also.

Of course these movements may take place in any other order, depending upon which system of levers meets with most resistance; but it is evident that the final position must always be the same for a given casting, and that the center line of any casting, and of the jig, must always coincide, regardless of variations in size of castings, within ordinary practical limits.

Having but one screw to operate, makes the jig very convenient for putting in and removing the work, and at the same time the construction is such, that the wear is not liable to disarrange it. Several tests made by the writer, of castings which had been drilled, showed that they were brought by the movement of the screw to precisely the same position every time they were placed in the jig,

regardless of their position at the beginning. The usual clamp passes over the work to hold it down firmly to the plate, though that is not shown on the drawings, as it is not connected with the centering arrangement.

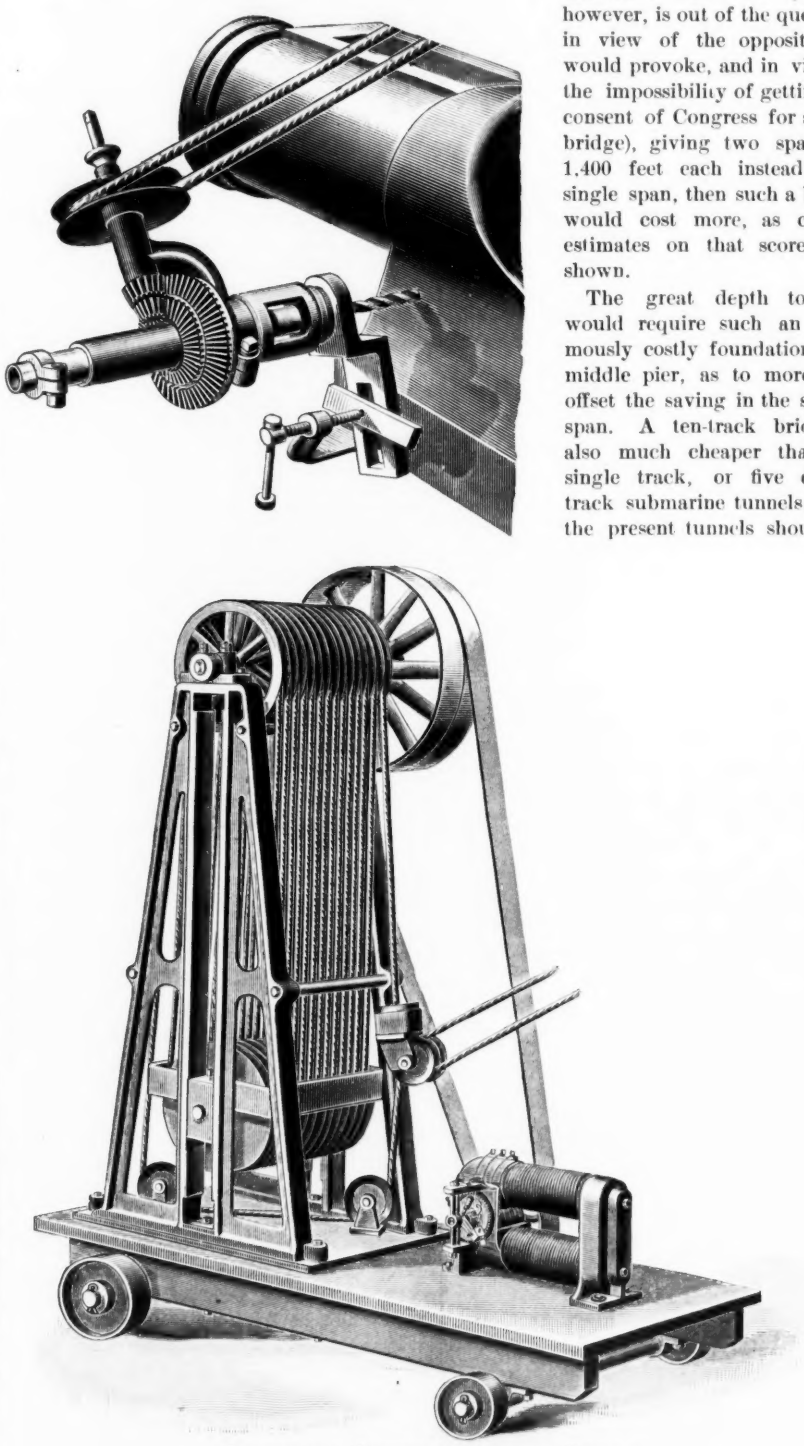
It will, of course, be evident that a similar arrangement of levers and sliding blocks can be adapted to castings or forgings of almost any form, and in fact Mr. Brady employs the principle for a variety of jobs other than the one specified.

Halsey's Portable Electrical Outfit for Driving Portable Drills.

In our issue of January 31, 1889, we described and illustrated Halsey's portable power drills. The illustrations in the current issue show another method of attaching the portable drill, and also one of the outfits for transmitting power to these drills. The value of this outfit will be perceived when the principle of its construction is understood. The portable drills can be easily changed from one position to another, they are light, one for drilling holes up to 1⅛″ diameter, weighs only 50 pounds. Now, in order to increase the usefulness of these drills, it is necessary to have a device for transmitting the power to the drill which will enable the operator to drill holes anywhere within a radius of 60 feet without changing the position of the driving device. But cases frequently occur, which, on account of the limited space, demand a very compact machine for transmitting the power. The device here illustrated was designed to meet all these requirements, for which we believe it to be admirably adaptable. The device, as here illustrated, simply consists of two multiple sheaves; guide pulleys, for leading the rope in any desirable direction; the framework, and an electric motor of five horse-power, all mounted on a truck. The upper sheave is driven by the motor, the lower sheave has freedom to move up or down to accommodate the length of rope required for reaching the drill set anywhere within a radius of 60 feet. It will be readily seen that a hole can be drilled close to the driving device, and when it is necessary to drill a hole 60 feet away from it, the lower sheaves will move up only a little over 4 feet 3 inches, provided that there are 14 sheaves on each axle.

This driving device is well adapted for drilling holes in ship frames between decks; it is also equally well adapted for locomotive roundhouse work, as it can be quickly transported and fixed in any part of the house. Another advantage is that it prevents an entanglement of the rope.

The portable drill, capable of drilling holes 1¼″ in diameter, can drill six inches deep; it has a feed of one hundred and sixty turns to the inch, and has all the requirements of a stationary drilling press for manipulating quickly, namely, quick return of spindle and friction feed. The device is manufactured by Mr. James T. Halsey, Morristown, N. J., who makes a specialty of portable power drilling machines. Sales agents, J. J. McCabe, New York, and Pedrick & Ayer, Philadelphia.



OUTFIT FOR DRIVING PORTABLE DRILLS.

The Proposed Bridge over the Hudson River.

Congress has been asked to grant to the North River Bridge Company the right to span the Hudson.

The proposed suspension bridge is to extend from Hoboken, N. J., to some convenient point near Fourteenth street, New York City. The company agrees to build, maintain, equip and operate the bridge, proper approaches thereto, and terminals, appurtenances, and works connected therewith, and to lay tracks thereon for the connection of railroads, and to facilitate transportation. It is also stipulated that the bridge shall have not less than six railroad tracks, and shall be constructed with a single span over the entire river, between the established pier lines in either State. No pier or other obstructions are to be constructed in the river between the pier lines.

The bridge is to be completed in seven years, unless delayed by legal proceedings. The bridge is to be built subject to the approval of the Secretary of War, who is to be provided with maps showing existing piers, docks, etc., and a profile of the bottom of the river. The Secretary is to regulate the height of the bridge, and the details of its structure. The bridge, with its approaches and railroads, are to be a lawful structure, and a military and post road.

The bridge is to have six tracks, and will be built strong enough for ten, so as to accommodate the thousand trains and sixty thousand passengers which pass in and out of Jersey City every day. The plans have been prepared by Gustave Lindenthal, an eminent engineer of Pittsburgh, Pa. The dimensions of the bridge, as proposed at present, are as follows: Length of bridge, including anchorage, 6,500 feet; height of anchorage, 210 feet; weight of each anchorage, 660,000 tons; length of each land span, 1,500 feet; length of middle span, 2,850 feet; size of towers at high-water mark, 340x180 feet; height of towers from high-water mark, 500 feet; height of towers from deepest foundation to top, 690 feet; width of bridge, 86 feet; clear height above high-water, 155 feet; number of cables, 4; length of one cable, 6,100 feet; finished diameter of cable, 48 inches; number of railroad tracks, 6 to 10; allowable speed of trains, 30 miles an hour; cost from anchorage to anchorage, exclusive of land damages, $16,000,000.

The bridge will not carry teams, because of the great cost of building the necessary approaches.

From the cable, arches will be suspended, the platform built of steel, and arranged in two stories for six tracks below, and four above.

The grandeur of the proposed work can hardly be realized from a mere description. If the bridge is built it will probably forever mark this country as the foremost in the enterprise and in the art of bridge building. When it is considered that from one tower to the other we can see a man only by the aid of a powerful field glass, or that the single span would swing clear over Manhattan Island, in the neighborhood of Fulton street, a conception of the space bridged over may be obtained. Mr. Lindenthal, in a communication to us, states that this is the only way in which the river could be bridged, if the navigation interests are to be considered. If a pier were allowed in the river (which, however, is out of the question, in view of the opposition it would provoke, and in view of the impossibility of getting the consent of Congress for such a bridge), giving two spans of 1,400 feet each instead of a single span, then such a bridge would cost more, as careful estimates on that score have shown.

The great depth to rock would require such an enormously costly foundation for a middle pier, as to more than offset the saving in the shorter span. A ten-track bridge is also much cheaper than ten single track, or five double track submarine tunnels. But the present tunnels should be finished by all means, to provide for the local travel, and as such they will be a great benefit and profitable, but they offer no solution for the railroad problem.

More Truth than Poetry.

Friend (to inventor)—Is it possible you have sold your interest in that patent for only $25,000?

Inventor—Don't you worry. I've got an improvement on it, all ready to patent, that he'll have to pay $50,000 to get.—*Chicago Tribune.*

Otis Brothers, who, it will be remembered, furnished two of the five elevators in the Tower Eiffel, have been obliged to sue M. Eiffel to recover a balance of $14,700, which they claim to be still due on the contract, M. Eiffel declining to pay this, on the ground that the contract was not fulfilled, inasmuch as the elevators were not up and running when the Exposition opened its doors. Otis Brothers claim that the contract only required them to deliver the elevators in working condition, and that M. Eiffel was to put them up, all delay being due to himself.

Otis Brothers have been liberally congratulated on the securing of this contract, but when the difficulties and inconvenience attending the conducting of a suit in a foreign country are taken into account, there may not be so much cause for congratulation after all. The elevators were those which ran from the ground to the second platform of the tower, and were conceded to be the most difficult ones to construct. They were, however, entirely successful and satisfactory, and earned a handsome profit on their cost. It is to be hoped that Otis Brothers will succeed in getting full pay for them.

It is a peculiarity of western furniture manufacturers that establishments located at interior points thrive better than those in the larger cities. It is no exaggeration to say, for instance, that the Chicago factories are having hard sledding to keep out of bankruptcy. Competition is ruinous, profits small, and expenses heavy. This obliges operators to skin prices of material, and the hardwood trade comes in for its share. But in such places as Grand Rapids and Rockford, the furniture trade goes along at an uninterrupted pace, new factories are going up yearly, and the business thrives. The reason for the prosperity of the industry in the smaller places is said to be the comparative cheapness and reliability of labor. In Rockford the majority of factories are run on the co-operative plan, the co-operators being mostly Scandinavians. Last year members of this nationality built six factories in Rockford. They are nearly all mechanics, and good ones, and work together for the common interest as one man. Surely the feasibility of co-operation is well illustrated in that city.—*Northwestern Lumberman.*

LETTERS FROM PRACTICAL MEN.

Force.

Editor American Machinist:

In your issue of January 2d I was interested in an article on Force, by "Pedro," but take exception to some statements made by him.

Being only a beginner in the study of theoretical mechanics, I am almost afraid to break a lance with him, but I am after information, and "nothing venture, nothing have."

He says: "Force is that which produces or tends to produce motion," and "is measured by the velocity which it generates in the unit of time"—*in the unit of mass* (I append the latter important factor). Here we are told that force may produce motion, and is part of and co-existent with the motion, which is perfectly true; but we are not told that force is an effect, as "Pedro" would have us infer. An effect is something produced, and the foregoing distinctly says that *motion* is produced.

What we are told is that the force is measured by the velocity, *i. e.*, amount of motion produced, produced in the unit of mass, in the unit of time.

I cannot interpret the foregoing rules as saying that force is an *effect*. But, as "Pedro" says, it is a confusing subject, and I may easily get astray, and, being astray, I will be thankful to any one who will put me aright.

Furthermore, I do not see how he subdivides forces into static and dynamic. Statics and dynamics are laws and sciences unto themselves, and treat more properly of conditions.

"Statics treat of the conditions of the equilibrium of bodies under the action of forces," and "dynamics treat of the motion of material bodies, and the laws of the forces which govern their motion." Allowing "Pedro's" subdivision of force to be admissible and correct, the above distinctly says that static force applies only to bodies at

rest, and *dynamic* force to bodies in motion—just the reverse of "Pedro's" statement.

Again, he states that "dynamic force is the amount of matter moved over a given distance in one minute." If force and matter are one and the same, that may be true; but the definition of force distinctly says the contrary, so that statement becomes an absurdity. Force is not the amount of matter moved, but it may be measured by the amount of matter moved, taken in conjunction with the time.

If I am in error I hope some one will correct me. LELAND.

Grindstones vs. Emery Wheels.

Editor American Machinist:

In your issue of January 9th I read with considerable interest an article by Prof. Sweet, in which the topic of tool-grinding received a good deal of attention. It impressed me as somewhat surprising that Prof. Sweet should be found looking backward and re suscitating the ancient grindstone, instead of shaking the (grindstone) dust from his feet forever. It does not become us, however, to condemn hastily the positive position assumed by the writer of the article mentioned—a position presumably based upon wide experience and a recent practical comparison of both systems of grinding. But, granting that this new theory is correct, it would be a sad commentary upon the mechanical judgment of the manufacturing public in general, to discover at this late day that all investments in emery wheels are but foolishness, and the result of poor judgment.

Prof. Sweet brings up his own experience, and that of another concern, as proof of the efficiency of grindstones for all grinding operations. This is somewhat unanswerable as far as it goes, but who doubts but that a legion of American manufacturers could easily be found to attest to the superior merits of the emery wheel, when properly used for the purpose for which it was intended? The grinding public is only just beginning to realize that a certain emery wheel is not adapted for universal grinding. A wheel suitable for casting snagging will not do good work grinding an edged tool, neither will a fine soft wheel designed for thin edged tools give much consolation in grinding heavy lathe or planer tools. It requires nice discrimination to select and grade the different qualities of emery wheels. An efficient and accurate system of testing emery wheels I consider one of the unfilled wants of the times. I have no doubt but what Prof. Sweet was a victim of somebody's poor judgment in selecting his emery wheel, and I should judge he was afflicted with a *hard grade*, or else the "$50 diamond" would yet be intact. It is a lamentable fact that emery wheel dealers do not dare to send out a sufficiently soft grade of wheel to give best results in cutting, on account of a lack of enlightenment among emery wheel users.

The only reason (besides cheapness) why the grindstone is tolerated at all is because it is generally of a soft consistency, and maintains a fresh and keen cutting surface. If it were impossible to obtain the requisite variety of grades of grindstone, it would, in my mind, effectually bar its introduction for modern shop tool-grinding. I cannot conceive of the successful operation of a grindstone on a universal grinding machine, employed, for instance, in grinding the inside of small hardened boxes.

O. S. WALKER.

Grindstones and Emery Wheels.

Editor American Machinist:

I read with a great amount of pleasure the article by Fay in your issue of the 23rd inst., in which he expresses my views exactly.

In the shop where I am employed there are about two hundred machinists, and four grindstones. It has always been everybody's business to turn up the grindstone, and therefore is nobody's business, and, as a consequence, they are always in a deplorable condition.

Some years ago a new machine was brought into the shop, the like of which the most of us had never seen before. We were informed it was an emery grinder for grinding tools, and that the days of bumphy grindstones and profanity were over. It worked like magic at first, but it was not long before the hard spots began to show themselves, and one day, while I was trying to grind a tool, it was jerked from my fingers and forced between the wheel and the case surrounding it. This put the emery wheel in a worse condition, after which it was abandoned.

Some time after, another machine was put in, which was claimed to possess several improvements over the former one. This one worked all right until one day it flew to pieces, severely injuring the young man who happened to be grinding at the time—after this occurrence the emery grinder was abandoned, and I don't suppose one could be sold to that establishment again.

W. R. E.

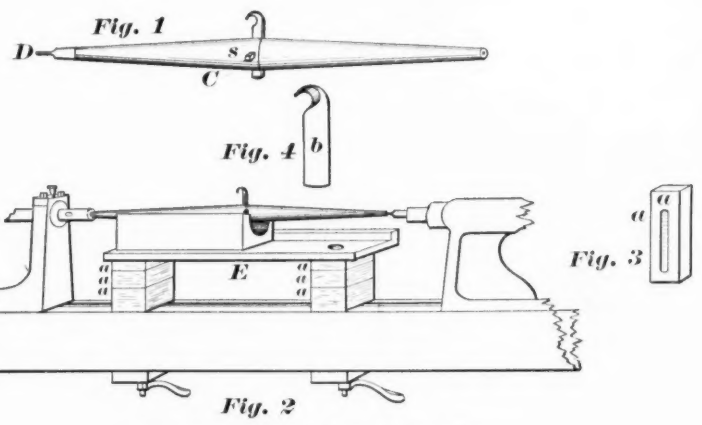
Attachment to Lathe for Making Core-Boxes.

Editor American Machinist:

In the sketch Fig. 4 is the tool bar, made of steel with a slot through the center to receive the tool. The end *D* has a taper shank which fits the spindle, by which it is driven. The tool is held and adjusted by means of a set-screw *S*.

One-half the core-box is bored at a time, being held in place by a board *E*, with a strip screwed to the back, as shown in cut. The board is lowered or elevated by blocks *a*, *a*, *a*, Fig. 3, with a slot for moving back and forth to bring the center line of core-box true with the center line of lathe.

The device for holding down is shown in the sketch. The half-box is moved endways



ATTACHMENT FOR MAKING CORE-BOXES.

under the revolving cutter, and is bored true.

First bore the halves with a bit large enough to receive the bar, then set the tool a little scant of required size and rough out; then set to size and finish.

Three sizes of bars will provide for boring a wide range of core-boxes, and they will do the work quickly and well.

CHARLES HUNTINGTON.

Profit-Sharing.

The Ingersoll-Sergeant Rock Drill Co., New York City, informed their workmen last spring that at the end of the year a part of its net earnings would be divided amongst them. The division has been made, amounting to $4\frac{8}{10}$ per cent. upon the amount each workman received as wages during the year. With, we do not doubt, a desire that the men shall save the amount thus received, the company makes them the following liberal proposition:

"To all who may so desire we will give, in the place of cash for the amount coming to them, a certificate representing such amount, bearing interest at the rate of 6 per cent. per annum, payable to the person entitled to it, personally on the first day of February, 1891, and all such as may elect to take such certificates instead of cash, for the amount coming to them, shall receive out of the net earnings of 1890 a sum one-fourth larger than those who elect to take cash."

Our attention has been called, by some of the workmen, to the action of the company in dividing profits. One of them expresses the opinion that the profits will be greater next year. Another writes as follows:

"Thinking it would be of interest to you, as well as to some of your readers, I would like to call your attention to the action of the Ingersoll-Sergeant Rock Drill Co., in dividing among all its employes a share of the profits of the company during the past year. As one of the employes, I think I can speak for all of them in expressing our satisfaction in the amount that each man or boy received. The share that each received was $4\frac{8}{10}$ per cent. of his yearly salary, so you can see that it was no mean amount that each received."

The American Patent System.

BY D. WALTER BROWN, PH. D.

II.

PRIORITY OF INVENTION—SUFFICIENCY OF THE SPECIFICATION—PROTECTION SECURED BY THE PATENT.

Our law requires that the patentee should be, in truth, the "first inventor." But these words have, in law, not quite so wide a meaning as they have in general use.

To be the "first inventor" does not mean that the applicant for the patent must be the first man in all the world to have devised the thing. But it does mean substantially this:

1. That the applicant for the patent shall be the first man to have invented that thing in the United States; and

2. That the same invention, if before invented in a foreign country, shall not have been patented or described in any printed publication anywhere before the American applicant invented it.

So a foreign inventor may have first invented and used the thing abroad, but that will not prevent the American from getting his valid patent here, if the foreign invention was not patented or described in any printed publication, before the date of the American invention.

Furthermore, it is not every prior foreign patent or publication which will prevent the American from getting his good patent, but only such foreign descriptions as are so clear and complete that a skilled person can take the foreign description, and from it make and use the same thing substantially as the American invention. Thus, for instance, a passing notice of a foreign invention in a report of a scientific society will not affect a later American patent. In short, the foreign description must be substantially as full and complete as it would have to be in the specification of an American patent.

Again, the meaning of the words "first inventor" must be restricted so as to meet cases like the following, which are of very common occurrence:

Suppose A is the first to conceive the idea of an invention, but B., who does not conceive the idea until after A., is more expeditious with his investigation and experiments, and gets practical results before A does. Which of the two men is the "first inventor"?

It is first necessary to understand what is meant by "conception of invention." A failure to comprehend this has caused to many the loss of valuable properties, or has led them into useless and costly litigation.

"Conception of an invention" includes the two following things: (1) That the inventor has got the idea that it would be well to do a certain thing. (2) That he has got an idea of the *means to do it*, substantially the same as the means he describes in his patent (supposing he applies for a patent). Only when he has got both these ideas has he "conceived of an invention" in such a way as to give him any rights. To merely get the idea that it would be well to do a certain thing amounts to nothing. Many an inventor is ignorant of this, and goes about claiming to be the inventor of something which some other has used or patented, simply because he (the claimant) first got the idea that that was a good thing to do.

But such a claim is idle. The law takes no note of it until it is shown that the man had also an idea of the means for doing the thing. But, granting that A. has such a complete "conception of invention," then the answer to the case supposed is this:

If A., having made this conception of invention, is as diligent as his health, his means, and the general circumstances of his life admit, in completing his experiments and reducing his invention to practical shape, then A. is the "first inventor," and entitled to the patent, although B. first got a practical result.

But if A. is negligent, and does not prosecute his experiments to a practical result as rapidly as he reasonably can, then his negligence loses his rights, and B. is entitled to the patent.

The very great importance of establishing the date of the "conception of the invention," and diligence in perfecting it, becomes apparent.

An inventor who has conceived of an invention should proceed with all practicable speed to bring his experiments to a point where they can be practically demonstrated. To sleep by the way may be fatal.

When he has got the idea of what he proposes to do, he should, at the earliest possible time, note down a brief statement of what he intends to accomplish, and the means he intends to use; in other words, make a brief description of his invention. He should make a rough, but substantially accurate sketch of his apparatus, and as any important step is taken in his experiments it should be noted down. The final clear result should be noted carefully. It requires but little pains to do this. A small memorandum, which should have the dates carefully noted, is sufficient. The thing is to get a record which will be proof of the clear, continued direction of the inventor's mind to the subject, from the first conception to the practical result, which record will show that his was more than a mere hap-hazard idea which ended in nothing.

For lack of such evidence, many an inventor has lost the fruit of his toil, because he could not prove he had ever advanced beyond the first crude, incomplete idea.

Another question, which is closely connected with that of "first invention," and one which frequently arises, is the following: When a workman, in the employ of another, is directed by his employer to make a certain thing, and does make it, is the employe or the employer the inventor? As to this—

1. The law gives to every man, whether he be employer or employe, the patent for what that man invented; but

2. If an employer has conceived of the invention, as I have before explained, and tells the employe to make the thing, giving him the general idea of the thing to be made, then the employer is the inventor, and entitled to the patent. In this case, the skilled work of the employe gives him no claim to the patent.

So, generally, when an employer has given such a general idea of the whole machine to the employe, any improvement which is designed by the latter while making the machine belongs to his employer; but—

3. If an employer merely suggests to his employe that it would be well if a certain thing could be done, and the latter goes ahead and devises the means to do it, then the employe is the inventor, and entitled to the patent; and, finally—

4. If an employe makes an invention in the time of his employer, and with his employer's tools, etc., then, although the employe is the inventor, he will generally be

held to have given his employer a license to use the particular machines so made, without fee.

THE DESCRIPTION IN THE SPECIFICATION.

When taken with the drawings of the patent, the description must be so clear and complete that the reading of it will give to a person, skilled in that special line of business, all the information he needs to make and use the thing. It is not necessary, however, that the specification should be so full as to instruct one who knows nothing of the subject how he can go to work to make and use the thing. Patent specifications are not primers for primary schools—they are directed to the men who understand that particular business, and it is absolutely necessary they should give those men all the information needed, *without any further experiment*, to make and use the invention. A specification which does this is sufficient.

THE PROTECTION CONFERRED BY THE PATENT.

The patent, when granted, gives to the inventor and to those to whom he sells any part of the patent, the exclusive right for seventeen years of making, using, and selling the invention in all parts of the United States and its territories. During the life of the patent no other person than the inventor, or to those whom he sells the right, can either make, use or sell in any part of the same territory. These rights are enforceable in the United States courts, where, by proper suits, the inventor, or his assigns or representatives can prosecute any one who, in any part of the country, at any time during the seventeen years, does either of the above things without authority.

In such suits, the inventor, and his assigns and representatives, can obtain damages for past infringements, can compel the infringer to discover whatever profits he has made out of his unlawful use of the invention, and can obtain injunctions restraining the infringer from making any further use of the invention thereafter, unless he obtain from the inventor, or other owner of the patent, authority to use it.

Of course, the patent gives to the inventor, and his assigns and representatives, the right to grant licenses, shop rights, etc., for making, using or selling the invention, and no others have the right to grant any such licenses.

The patent secures all these various privileges to the inventor for seventeen years, and no longer. A patent cannot be extended beyond the first seventeen years, except by a special Act of Congress. Practically, it may be said, a patent cannot be extended at all.

When an inventor sells a part, as say a half interest in his patent, intending the patent shall be worked for the joint benefit of himself and his assignee, it will often be of very great importance that the exact rights and obligations of each party be carefully set out in the assignment. It is very common to draw assignments of part interests so that the inventor simply sells the half or other interest generally, without any statement of the exact rights and obligations of each party. When this is the case, the law is very unsettled as to what remedy, if any, either party has against the other for proceeding to realize more than his share out of the patent. Thus, in such case, if one of the owners of the patent should go ahead and grant licenses all over the country, it is not by any means settled what remedy the other would have. Therefore it will often be of great importance that the assignment be very precise about all this; as for example, that no licenses shall be granted except by all the owners of the patent jointly, and that all proceeds, or net proceeds, shall be apportioned in the certain specified way.

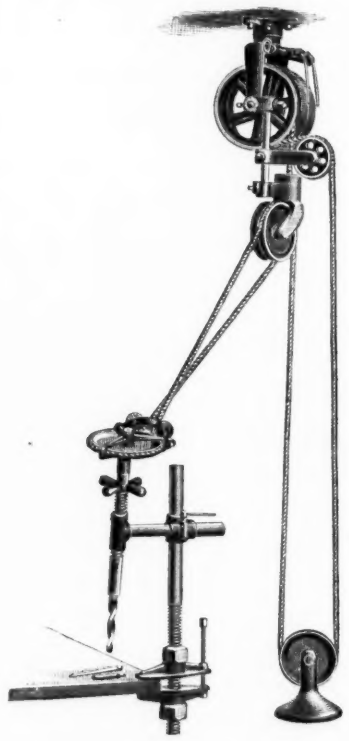
The production of pig-iron in this country in 1888, though the largest up to that time, has been surpassed by about 12 per cent. during 1889, according to a supplement issued by the *Bulletin* of the American Iron and Steel Association. The production of net tons in 1888 was 7,268,507, and during 1889, 8,517,068 tons. It was predicted at the beginning of 1889 that our production of pig-iron would probably surpass that of England, and place us in the front rank among the nations of the world as producers of pig-iron. But, in this prediction, it seems not enough allowance was made for the fact that England's iron industries were enjoying a boom fully equal to, if not surpassing ours, and that this would lead to an increased production there also.

It is estimated that she produced last year about 700,000 gross tons more iron than were produced here, and the *Bulletin* does not think we will surpass her this year, if trade conditions remain the same in both countries as now.

Portable Power Drilling Machine.

The drilling mechanism of this machine is simple, being only such as is required for clamping to some part of a machine or piece in which a hole or holes are to be drilled, and means of adjustment to drill at any angle.

The countershaft is of the universal kind. It consists of a socket, which is first bolted to the overhead timbers by three screws, when the yoke spanning the pulleys is inserted, and a set screw in the socket is turned to place; the point of the screw fits into a groove in the end or upper part of the yoke. The pulleys are lined up by guess until the



belt is put on, when they are lined by turning the yoke slightly until the belt runs in the center of the loose pulley; the shipper is operated by a cord, not shown in the cut, and a spring holds the belt on the loose pulley when not in use. Guide pulleys provide for leading the driving rope in any desired direction.

The general construction and arrangement is so well shown that further description is unnecessary. It will be understood that, by inserting lengths of rope, the drilling may be done at any desired distance from the countershaft. The driving mechanism can be used for driving other machinery than the drill, when desirable.

The manufacturer is Albert L. Colburn. New Haven, Conn.

Accidents to brakemen in coupling cars have long since become so common that newspaper correspondents have received orders not to telegraph reports of them to metropolitan journals unless attended by some remarkable circumstance. The experience of James McCann, a brakeman in the employ of the Western New York & Pennsylvania Railroad, was evidently considered sufficiently horrible to justify printing the account of it, since it was telegraphed to the New York papers.

On the night of the 23d of January he was working in the yard at Olean, N. Y., and in attempting to couple some cars which had been backed down by a switch engine, was caught, and his hand crushed between the bumpers. The switch engine having finished its work there, was taken away, and McCann, who was unable to extricate his mangled hand, remained there alone for three hours, until a trackman, happening to pass by, heard his groans, and, procuring help, extricated him; so badly frozen, and with his nervous system so shattered by his frightful sufferings, that there is little hope of his recovery. It is to be hoped that the day is not far distant when such an accident will be made impossible.

Testing the Alignment of Lathes.

BY B. CRANK.

Several different plans for testing the alignment of lathes have appeared in the columns of the AMERICAN MACHINIST at different times; some of them very good, but about all of them involving the use of some specially made and sometimes expensive appliance to get the desired results. This leads the writer to present a simple and inexpensive but accurate plan, used on two occasions with good results.

Take a piece of iron of sufficient length to include not less than five feet between centers, and have a collar welded on each end, or upset at each end so that it may be turned at each end to a diameter that will be about one-eighth inch larger than the portion between ends. Center it accurately by reaming the center and drilling with a small drill so it will not bear on the point of the lathe center. Turn both ends smoothly and to the same diameter exactly, by reversing the piece in the lathe, and not disturbing the adjustment of the turning tool. Round up the end of a piece of $\frac{3}{8}$" square iron about the shape that the end of a gauge would be made for taking the size of a hole. Bend that end up at about a right angle, and then curve it downward so as to give it a swan-neck shape Fasten this in the tool-post so that the rounded point will pass over the turned end of the bar in the lathe (which we will term a test bar) by turning the cross-feed screw.

Get a small piece of writing paper, and place it on top of the turned end of the test bar next to tail-stock; pass the iron point back and forth over the paper by turning the cross-feed screw, meantime moving the paper back and forth between the point and the bar, to feel if it pinches the paper while passing over the center line. Now, if the gauge is screwed tight enough in the tool-post, it may be adjusted by taps of a hammer, bending it slightly, until it will just barely pinch the paper in passing the center, yet not tight enough to tear it. By a little practice this will be found to be a very accurate way of gauging the distance between the test bar and the gauge. Right here let the younger readers be warned not to depend on examining by the eye to determine if the gauge touches the test bar, for the sense of feeling with the paper is as much superior to seeing as a standard gauge is superior to the old rule and caliper plan of measuring an exact size. Now run the carriage up to the other end of the test bar, and try it there with the paper, and if it feels the same there, and the live center runs true, then the centers are both the same height. If it does not pinch the paper there, introduce additional thickness of paper until it feels the same as the other end did, and the additional thickness of paper will represent just how much too low that the center is.

To find if centers are parallel with the shears the other way, place another gauge point in the tool-post, just the height of the center line and pointing toward it, and then, with the paper between this gauge and the test bar, adjust the point by turning the cross-feed screw until it pinches the paper as before. Without disturbing the adjustment of the gauge, run the carriage to the other end of test bar, and see if the paper will feel the same; if not, then adjust the tail-stock until it feels the same at both ends. The centers will then be parallel with the shears. But that is not all which is desired to be known, for it has not been shown yet whether the live spindle is in line with the shears. To test this, fasten on the test bar, with a dog near the face plate, a piece of small, square iron, with a gauge point on it, pointing toward the face plate nearly at its outer diameter. Select a spot opposite the pointer on the face plate, and mark it plainly so you will not lose it. Place this spot vertically above the center, and the pointer also, and with the piece of paper adjust the point as before. Turn the face plate and pointer vertically below the center and try the paper, and if the touch is the same, then it shows the spindle is parallel with the centers in that direction. Turn the spot and the pointer until level with the centers at the back of the lathe, and adjust to the paper; then turn to the front and try the paper. If the touch is the same, then, of course, the spindle is parallel with the centers. If a difference is found at either of the trials, insert pieces of paper where the gauge is farthest from the face plate, until it touches alike at the two opposite sides, and the additional pieces serve to show how much it is out of line.

To illustrate, suppose that it was found that with the gauge just right at the vertical above the center, it would take double the thickness of paper at the lower vertical. Let the radius of the gauge point from center of test bar be 10", and the spindle boxes be 20" from center to center, then by putting one thickness of paper under the front box of the spindle it will be brought up in line with the tail-stock center. It will be found usually on a lathe that is worn out of line that the front box has worn down the most; and, by putting a liner under the box, it brings the center the right height, and also brings the spindle up in line with shears; but when it does not, then the tests must be repeated in the same order as before, viz., first find if the test bar is parallel with the shears, and, second, find if the spindle is in line with test bar. At a little additional expense, a crook could be made to put in tool-post, bent up over the test bar, and having a round point set-screw neatly fitted, so that it could be adjusted to touch the paper, instead of adjusting with a hammer. Also an arm might be fixed on the test bar about as long as would swing past the shears, having near its end another set-screw so it could be adjusted to touch the paper. If there should not be a large face plate to the lathe to be tested, it will answer just as well to bolt a parallel piece to the small plate, allowing it to reach out to nearly the full swing. With these few simple appliances, and proper care on the part of the user, a lathe can be tested as accurately as by any method in use.

Young women, and for that matter many young men as well, might draw inspiration and a very useful lesson from the success attending the efforts of Sophia Braeunlich, who has recently been appointed to the responsible position of business manager of the *Engineering and Mining News*. Starting a number of years ago as the editor's secretary, she employed her spare moments in acquiring information regarding matters connected with mining, and soon became remarkably well posted in all matter pertaining to the field which the journal occupies. Her abilities were recognized, and she was advanced from one position to another, until she now becomes the sole business manager, a position which she has already shown herself thoroughly competent to fill.

Father (to editor)—"I would like you to give my son a chance in your printing office." Editor—"What can the boy do?" Father—"Well, at first he couldn't do anything more than edit your paper, and take general charge of the mechanical department; but later on, when he learns sense, he'll be handy to have around to wash windows, keep lamp chimneys clean, and sift ashes."—*Mercury*.

England has a total of 367 war vessels, of which 76 are armored. France comes next with 260, and 57 of these are armored. Even China has 7 armored and 66 unarmored war vessels.

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Try One Thing at a Time.

It would seem that there are mechanics who would do well to learn a lesson from scientists, who, in conducting an experiment of any kind, are always extremely careful to introduce no feature, however slight or unimportant it may appear, which can in any way affect the result without taking full account of it, and making the proper allowance. When Professor Tyndall tested the diathermancy of air, he was particular to have nothing in the tube through which he sent his radiant heat but pure air, and he closed the ends of the tube with plates of rock salt—a substance which, by previous experiment, had been proven to possess the highest transmissive powers. In other words, he took great pains and exercised much ingenuity in devising means for having the heat pass through nothing which could affect it except that, the diathermancy of which he wished to test.

Some instances in which mechanics have jumped at conclusions regarding certain matters, without their being first sure that the specific thing to be tested was tested by itself, and without complicating circumstances, have recently occurred. One of these has been brought up by some correspondence which has recently appeared in our columns regarding the respective merits of grindstones and emery wheels for ordinary tool grinding. It is clearly shown by this correspondence that the respective merits of the two have been by no means tested yet in any fair way, and that it is by no means impossible that many mechanics have been led to an entirely erroneous conclusion on the subject, simply because there have been other, and what appear to be important modifying circumstances attending the respective tests.

The same error is being made in some instances in the testing of the compound principle as applied to locomotives. When a compound locomotive is to be built, there are usually quite a number of things which the builder thinks he may as well embody in his design, which are not really necessary to the test of the compound principle, and are not used on ordinary engines, often for the very good reason that they have been found impractical there. When such an engine fails, how can its failure be attributed to the fact that it is a compound? Evidently it can no more be attributed to this than to any of the other changes from the common design, unless those changes are necessary features of a compound engine.

Another instance of the same kind is in the case of the "Swinerton" locomotive. The main feature of this engine, and the one for which the principal claims were made, was the tires which have numerous flat places milled upon them. But at the same time the engine embodied other radical departures from the regular locomotive practice of this country, and the performance of the engine could with as much reason be attributed to these other features as to the tires. We understand that the tires alone are soon to be tested on the Pennsylvania road, and on the elevated roads of this city, by taking the ordinary tires of a standard engine and substituting the Swinerton. Such a test will show what the tires are worth, and no test conducted on an engine embodying other departures from standard practice can be considered conclusive or at all reliable.

A Decision Regarding Workmen's Contracts.

A recent decision of the Supreme Court of Connecticut regarding contracts between workmen and their employers is of some interest. A law of the State provides that "Any person or corporation who shall withhold any part of the wages of any person because of any agreement, expressed or implied, requiring notice before leaving the employment, shall forfeit $50, half to him who shall sue therefor, and half to the State."

The case decided was one in which there had been an express agreement that the workman should give two weeks' notice of an intention to quit work, and in case he should quit without giving such notice, was to forfeit two weeks' wages. On the other hand, the employer was to give two weeks' notice of an intention to discharge the workman, and, failing to give such notice, was to pay him two weeks' wages. The workman quit without giving notice, and the penalty was enforced according to the terms of the contract. The workman brought suit under the law quoted above, and in the lower court obtained judgment, on the ground that it was not shown or claimed that the employer had sustained damage by reason of the quitting of the workman without notice. On appeal this decision was reversed by the Supreme Court, on the ground that the decision "virtually put into the contract what the parties did not place there; that a breach should entitle the other party to such damages only as he could show he had sustained; whereas, the parties in effect agreed that a sum equal to two weeks' wages should be regarded as limited damages."

This, we think, must be regarded as an instance in which common sense, justice and law agree. The contract was undoubtedly a fair one, laying obligations of a similar nature upon each of the parties to it, and imposing precisely the same penalty upon either party for a breach. It is the one-sided contracts, where all the obligations and all the penalties are on one side, that the courts are continually upsetting, when brought fairly before them, and which every lover of justice rejoices to see declared illegal.

How One Young Man Helped Himself.

We recently received a letter from a young man, that is typical of a good many we receive during the year. This one carries with it so plainly a lesson we have often tried to impress, that we cannot resist the temptation to make use of part of it. The writer says, after the information that he has just been appointed mechanical superintendent of an important works:

Eight years ago I was working as a young journeyman machinist, with no expectation of getting above that position.

About that time, an article in the AMERICAN MACHINIST, on educating oneself set me thinking that I might do better as well as others, and I went to work all by myself, evenings. It seems to have paid me.

This is what we have always urged, viz., first, that, if a mechanic acquired knowledge in the line of his work, beyond the mere routine duties, he will find a market for that knowledge, and second, that any young mechanic of intelligence can educate himself if he tries. It will take him a little longer to do so than if he had the advantages of some of the excellent technical institutions; but, on the other hand, he will spend less time over things not likely to be of much practical use to him. Any man who goes through the world, lamenting the lack of a technical education, simply advertises himself as incompetent.

The *Newark Advertiser*, in view of the raising of the salaries of New Jersey officials, says: "The old-fashioned notion was that the honor of being Governor of New Jersey was worth something." Well, this "old-fashioned notion" has caused a good deal of trouble in this world. A man is worth his wages, whether he works in a shop, or has got a job as Governor of a State, and the idea that State and United State officials ought to work for something less than they can live on has been productive of a good deal of stealing, and other crooked things. And it does not work much better in private than in public affairs.

The recent destructive and terribly fatal explosion of natural gas at Columbus, Ohio, is another reminder that man, in bringing the forces of nature into subjection to his will, must always remember that those forces are as ready to destroy as to serve, and that nature knows no pity, but always and invariably inflicts the full penalty for violation of her laws. It has been found in this instance that a joint of the gas main had been left unfilled, and the escaping gas forced its way through the soil into some cellars, combining with atmospheric air to make the explosive compound, which reduced two houses to fragments, killed six persons and wounded nearly thirty others.

QUESTIONS AND ANSWERS

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(44) S. W. E., Richmond, Ind., writes: Please inform me as to where I can obtain full information in regard to making blue prints? *A.*—See answer to Question 449, in our issue of November 5, 1887; also see article on blue prints, in our issue of January 29, 1887.

(45) Reader, ———, asks: Will you kindly inform me what stuff you have found most efficient for removing the glossy surface of tracing cloth? I have been using pulverized chalk, but it is not satisfactory. *A.*—We have always used pulverized chalk with good results, and do not know of anything better. The fault may be in the cloth; try another quality.

(46) E. W., Brooklyn, N. Y., asks: Can you tell me any way to harden and temper small reamers with milled grooves up to ¼" diameter and 3" long, to prevent springing, and make them bright like small twist drills? *A.*—The process used for drills would not be adapted to reamers unless large numbers are to be hardened at a time. The best way to proceed is to harden them in a lead bath and then brighten the flutes on an emery wheel or otherwise, and draw the temper by laying them on a piece of hot iron.

(47) ———, New York, writes: A fly-wheel weighing 1,500 pounds is properly balanced and supported in bearings. One of the arms forms a crank one foot long; this crank is connected by means of a connecting rod, 4 feet long, to a lever above: this lever is 12 feet long, and the fulcrum is 5 feet from the end, which is connected to the rod. Can a man keep this wheel in motion at the rate of 100 revolutions per minute after it has been speeded up to that rate of speed? If not, why not? *A.*—No; because he will have to perform a work equivalent to about 27 pounds raised through 560 feet per minute, which is too much for one man to do.

(48) "Backwoods," ———, asks: Can you inform me where I can obtain shrink rules for brass 12⅞ inches to the foot, and made of steel? I find the makers of rules do not care to make them if it is not in their line, yet I have met many pattern makers who desire them of steel, as they consider them more economical (all things considered), but cannot get them. *A.*—We do not find such rules catalogued, and do not know where they can be obtained, though we have no doubt there are manufacturers who would place such scales on the market if they could be convinced that there was sufficient demand for them to make it worth while.

(49) C. R. F., Newark, N. J., writes: Please give me a rule for finding the horse-power of a compound engine. What bothers me is this two and three cylinder business. *A.*—See answer to Question 346, in our issue of September 12, 1889. 2. What is the tensile strength of iron and steel, such as is used for boiler stay bolts? *A.*—The ultimate tensile strength of bar iron is about 50,000 pounds per square inch. Iron stay bolts should not be subjected to a greater stress than 10,000 per square inch; the Board of Supervising Inspectors do not allow more than 6,000 per square inch The ultimate strength of steel bars is about 100,000 pounds per square inch. Steel is not often used for stay bolts.

(50) D. W., Montreal, Can., writes: What is the pitch of a tap that has 11, 9, 8 or 20 threads per inch? There is an idea here among a great number of machinists, young and old, that a tap, say ⅞ inch diameter 11 threads per inch, is ⅝ pitch, or 10 threads ¾ pitch; in fact, all taps in our toolroom are stamped after that fashion. A few of us argue that this is not right. Would you clear this up for us, as it would be valuable to a number of apprentices here in the Grand Trunk shops? *A.*—We suppose the idea in marking them thus is to indicate that the pitch of the tap is the standard pitch of the size tap indicated by the marks. Thus, if a tap of any size is cut with 11 threads per inch, its pitch is the standard pitch for a ⅝ tap, while, if it is cut with 10 threads per inch, its pitch is that of a standard ¾ tap. It is a novel way of marking taps, however, and we do not know of its being done elsewhere. The usual plan, and the one followed by the manufacturers of taps and dies, is to mark the size of the tap, and, following this, the number of threads per inch, leaving it to others to determine whether or not it is "standard" pitch, or, if not, what size standard its pitch corresponds to.

(51) A. M., Derby, Conn., writes: The capacity of my planer is 4 feet square; length of table, 20 feet. What is the fastest speed for the table, and to have it suitable for milling purposes? Also, what must be the speed of the milling cutters? *A.*—The speed of the cutting tools varies so much with the character of the work, that it is impossible to give any rule. The speed of the cutting tools is limited by the heat produced by their action, and this heat must never be so great as to affect the temper of the steel. White cast-iron is usually cut at a speed of about 5 feet per minute, steel and grey cast-iron 10 to 20 feet, wrought-iron 18 and 25 feet, brass 50 to 100 feet. Soft steel and wrought-iron are milled at speeds from 20 to 30 feet, cast iron from 30 to 50 feet, and brass at about the latter speed.

(52) Apprentice, San Francisco, Cal., writes: I am building a small locomotive; the eccentrics are to be cast together. How much angular advance do they require? The valve has $\frac{3}{64}$ of of an inch lap, $\frac{5}{64}$ lead. *A.*—Describe a circle (Fig. 1)

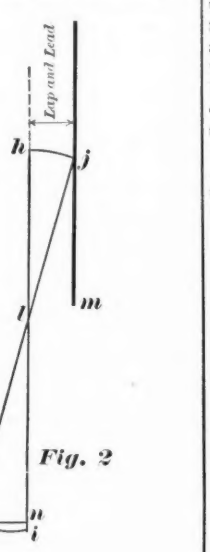

Fig. 2

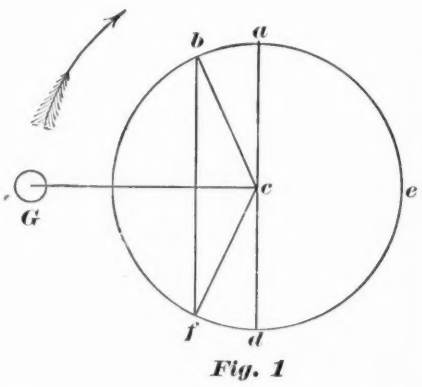

Fig. 1

whose radius $c\,a$ is equal to the sum of the width of the steam port and the lap, or one-half the travel of the valve; draw the diameter $a\,d$, and parallel to this diameter draw the line $b\,f$; the distance between $a\,d$ and $b\,f$ must be equal to the sum of the lead and lap. The line $b\,f$ intersects the circumference of the circle in the points f and b; the point f will be the center of the forward eccentric, and the angle $f\,c\,d$ will be its angular advance when the crank is at G. The point b will be the center of the backward eccentric, and the angle $b\,c\,a$ will be its angular advance when the crank is in the same position. Here, of course, we have assumed that the rocker arms are of the same length. If the arms are of unequal length, the angular advance is found in the following manner: Draw a straight line $h\,i$ (Fig. 2) from the point l on this line, and, with radius $l\,h$ equal to the length of the upper rocker arm, describe the arc $h\,j$. Draw a line $j\,m$ parallel to $h\,i$; the distance between $h\,i$ and $j\,m$ must be equal to the sum of the lead and lap. The line $j\,m$ intersects the arc $h\,j$ in the point j; through this point and the center l draw the line $j\,k$; from the center l, and with a radius equal to the length of the lower rocker arm, describe the arc $k\,i$, terminating in the lines $j\,k$ and $h\,i$. Through k draw a line $k\,n$ perpendicular to $h\,i$. Lastly, in Fig. 1, make the distance between the lines $a\,d$ and $b\,f$ equal to $k\,n$; the points f and b, in which the line $b\,f$ cuts the circumference of the circle, will be the centers of the eccentrics. When the rocker arms are of equal lengths, the travel of the valve will be equal to the diameter of the circle in Fig. 1. When the lower rocker arm is longer than the upper one, the travel of the valve will be less than the diameter of the circle; hence, in the latter case, if the travel of the valve is given, the diameter of the circle must be proportionately increased. Whether the line $b\,f$ shall be drawn perpendicular to the center line $G\,c$ of the crank, will depend on the relative positions of the center line of motion of the piston and that of the valve gear.

(53) W. S. L., Providence, R. I., writes: A paragraph in Mr. Joshua Rose's Modern Machine Shop Practice, Vol. 1, page 67, is attracting considerable comment among certain mechanics. I quote the paragraph at length: "If, instead of supposing all the strain to fall upon one tooth, and calculating the necessary strength of the teeth upon that basis (as is necessary in interchangeable gearing, because these conditions may exist in the case of the smallest pinion that can be used in pitch), the actual working condition of each separate application of gears be considered, it will appear that, with a given diameter of pitch circle, all other things being equal, the arc of contact will remain constant, whatever the pitch of the teeth, or, in other words, is independent of the pitch; and it follows that, when the thickness of iron necessary to withstand (with the allowance for wear and factor of safety) the given stress under the given velocity has been determined, it may be disposed in a coarse pitch that will give one tooth always in contact, or a finer pitch that will give two or more teeth always in contact, the strength in proportion to the duty remaining the same in both cases." Now, Messrs. Editors, if I understand Mr. Rose aright, his meaning, briefly stated, is that, with a pair of gears of given diameter and velocity, the arc of contact and strength of teeth is the same, regardless of the pitch. If I do not understand Mr. Rose, will you kindly explain what he does mean? or, if his language is correctly interpreted, is he not wrong in the above statement? Surely the arc of contact and strength of teeth are greater in a pair of wheels of coarse pitch than in a pair of fine pitch under the conditions assumed. It is insisted by some of the parties to this discussion that Mr. Rose is misunderstood; if this be so, and this communication should meet his eye, he will doubtless favor us with an explanation. *A.*—Assuming your quotation to be correct, we do not see how any other interpretation can be placed upon the language than that which you give it. We do not think the statement is correct.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Gear wheels and g-cutting. Grant, see adv., p 16.

Link-Belting and Sprocket Wheels.
Send for Catalogue of Link Belting.
Over 50,000,000 feet of Link Belt in use.
Link-Belt Engineering Co., Philadelphia and N. Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Drop Presses, Punches and Shears. Williams, White & Co., Moline, Ill., manufacturers.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor Fulton and Dutch sts., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

The best Upright Hammers run by belt are made by Jenkins and Lingle, Bellefonte, Pa.

Ice and Refrigerating Machines, 140 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

"How to Keep Boilers Clean." A 96-page book mailed free by Jas. E. Hotchkiss, 120 Liberty st., N.Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Castings for small and medium sized vertical engines. Humphrey's Foundry, Bellefontaine, Ohio.

Milling Machines. Pedrick & Ayer, Philadelphia, Pa.

Universal Grinding Machine. Pedrick & Ayer, Philadelphia, Pa.

For the latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Send $1 for Catalogue D, Fine Tools and Supplies. Over 550 pages. Fully illust'd. Free when $10 worth goods are ordered. Frasse & Co., 92 Park Row, N. Y.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See Jan. 30, p. 15. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Patent Attorney. R. G. DuBois, 715 11th st., Washington, D. C., procures first-class patents on inventions. Valuable Hand-book on patents free.

All sizes of Taps & Dies from 5-64 of an inch to 4 inches V, U. S. S., Whitworth, Square & Left-Hand Threads. M'f'd by S. W. Card & Co., Mansfield, Mass.

The Sure Grip Steel Tackle Blocks must fill the bill, according to the large sales reported. See advertisement, page 13.

Patents.—Patent soliciting of high class.
D. Walter Brown, 31 Nassau st., New York.
Send for "A Brief History of Patent Legislation in the United States."

25" Upright Drills a specialty. Finely made,
28" great capacity, quickly operated, prices low.
32" Send for list of firms using our Drills. J. E.
36" Snyder, Worcester, Mass.

25" } "Only Drill Press built on
32" } 'Ko-rekt' principles,
37" } even if they come from Jersey."
42" } Gould & Eberhardt, New Ark, N. J.

Standard Reducing Valve, Standard Pump Pressure Regulators, Improved Collignon Cylinder Oil Pumps, Jenkins Globe and Angle Valves. Send for circulars. Standard Regulator Co., Buffalo, N. Y.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations. 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon., 12 Cortlandt st., New York.

Superintendents of industrial establishments will find the *Engineering and Building Record*, published weekly at 277 Pearl st., New York, useful. Municipal and building engineering problems a prominent feature. Specimen Copy, 10 cents.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting Rods for small connections. Especially adapted for Valve Rod for Steam Engines.
T. C. Dill Machine Co.,
Philadelphia, Pa.

Just concluded. "Practical Drawing." By J. G. A. Meyer. Copies of the American Machinist containing the above series of 93 articles sent by mail to any address in the U. S., Canada or Mexico, for $4.65, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

H. B. Roelker, 22 Cortlandt St., New York, late Sup't De Lamater Iron Works, will hereafter manufacture the De Lamater Screw Propeller.
Propellers of same pattern and workmanship as formerly made by the De Lamater Iron Works. Each designed for its special work at lowest prices.
Consulting Expert and Constructing Engineer.
Estimates made on machinery and on damages.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

Just concluded. "Modern Locomotive Construction." By J. G. A. Meyer. The above series of 106 articles, which have attracted so much attention everywhere, is now concluded in newspaper form. Copies of the American Machinist containing the entire set sent by mail to any address in the U. S., Canada or Mexico for $5.30, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

MANUFACTURES

The Farmers' Alliance will build an elevator at Oak Hill, Kan.

The Eufaula (Ala.) Cotton Mills will increase the capital stock to $200,000.

The Whitcomb Metallic Bedstead Company, Birmingham, England, will start works at Birmingham, Conn.

Underwood & Coman have embarked in the wholesale lumber commission business at Menominee, Mich.

The capital stock of the Salisbury (N. C.) Cotton Mills has been increased to $133,000. More machinery will be put in.

The Gasten Lumber Manufacturing Co., of Cadillac, Mich., has been organized, to manufacture hard-wood lumber.

Belfast, Me., has offered to release from taxes for ten years any firm that will establish a shoe factory with $10,000 capital.

The Barbourville Wood-working and Manufacturing Company, of Barbourville, Ky., will build a planing mill and furniture factory.

There is water-works agitation at Belair, Md.; Reidsville, N. C.; Newton, Mass.; Cattaraugus, N. Y.; Albany, Ga.; Helena, Kan.; Frostburg, Md.

The Crescent Soda Co., of Louisville, Ky., has been incorporated, for the manufacture of bicarbonate of soda. The authorized capital is $1,000,000.

The Board of Trade, of Ware, Mass., has purchased a tract of land, and propose to raise money for the erection of a power building for manufacturing purposes.

W. F. & John Barnes Co., Rockford, Ill., send us a neatly printed and illustrated catalogue of foot and power lathes, and other machine tools and machinery made at the works.

The Union Bridge Company will abandon its works at Buffalo and move to Athens, Pa., where it has branch works. The works at Athens will be increased so as as to employ 800 men.

The Ironton Rolling Mill Company has been organized, to lease the works of the New York and Ohio Iron and Steel Company, of Ironton, O. The product will consist of sheet and tank iron.

The St. Louis Expanded Metal Company will build new shops, 80x109 feet. At present two stories will be built, with the intention of adding four more. The company has outgrown its present facilities.

The Tyler Tube Works Co., of Boston, has decided to move its plant to Washington, Pa., and invest $50,000. Local capitalists will put another $50,000 into a rolling mill to supply the tube works with material.

Capitalists have purchased 600 acres of ground near New Brighton, Pa., at the intersection of the Pittsburgh & Western Railroad and Conoquenessing Creek, and will locate thereon a number of manufacturing plants.

The Tallapoosa (Ga.) Cotton Co. has been incorporated by W. P. Harvey and others, with a capital stock of $100,000. The company will erect a three-story brick building 152 feet in length, a one-story brick, 25x39, and another, 30x45 feet.

The Judson L. Thomson Manufacturing Co. has been organized at Portland, Me., with a capital stock of $700,000 paid in. President, Judson L. Thomson, Syracuse, N. Y.; treasurer, Wilbur G. Davis, Concord, Mass. The company will manufacture buckles, rivets and different kinds of hardware specialties.

Jones & Mack, Cincinnati, Ohio, whose shop was recently burned, write us as follows: "We have made arrangements for another shop, and will be able to fill orders for our I X L drawing table with only about two weeks delay, or less."

The Swinerton polygonal driving wheels, soon to be tried on the elevated road, were milled by Beaman & Smith, of Providence, R. I., who made a special machine to do the work. The machine is said to be very successful in its operations.

The H. G. & H. W. Stevens Carriage Co. has organized under the laws of Maine, with a capital stock of $250,000. Factories will be erected at Merrimac, Mass. The officers are: President, J. O. Whitten, Boston; treasurer, H. O. Delano; directors, H. G. Stevens, H. W. Stevens, H. O. Delano, J. B. Little; superintendent, H. G. Stevens.

Bridgeport Machine Tool Works, E. P. Bullard, proprietor (machine tools, Bridgeport, Conn.), write us: In reply to your inquiries in regard to business for the year past, will say that we have run full during the entire year, reduced our stock of machines quite largely, and have orders well ahead into 1890. We feel well satisfied with the result of our year's labors.

The Pittsburgh (Pa.) Reduction Co. is now increasing its plant for the manufacture of aluminum to more than six times its present capacity. The company has placed orders for two dynamos of 2,500 amperes by 50 volts, two compound condensing engines of 200 horse-power each, and three boilers of 208 horse-power each. An iron building, 70x120 feet, is being erected to cover the plant.

It has been decided to locate the Keystone Paper Bag Company, recently organized in Pittsburgh, with a capital of $100,000, at Irwin, Pa. The erection of buildings will be commenced as soon as possible. The building will be 80x100 feet in size, and three stories high. The capacity will be about 25,000 pounds of bags per day, and will be increased as business justifies. C. T. Horner, of Pittsburgh, is president of the company.

A Portsmouth (N. H.) dispatch says: The largest fire that ever occurred at the Kittery Navy Yard broke out this morning at 8 o'clock in the boiler-room of the building No. 45, occupied by the construction and repair department as machine and iron plate shops. The fire quickly extended along the shafting and oily timbers into building No. 45, occupied as a futtock mill, and workmen were obliged to jump through the windows to escape. A general alarm was rung in, and four steamers belonging to the Navy Yard department were quickly on hand. Despite the efforts of the firemen and the marine guard, the fire extended into the machine shop, and help was then called for from this city.

A Gloversville (N. Y.) dispatch says: Petroleum was struck Saturday morning on the farm of S. H. Kennedy, near Johnstown. The well was being sunk to discover natural gas. Three distinct veins of gas had been passed, and the indications of oil promised a liberal supply. The well had reached a depth of 960 feet. The oil was only tapped, but it rises to a height of 600 feet through a seven inch casing. Intense excitement prevails, and thousands are visiting the well, which is being sunk by the Mohawk Heat, Light and Power Company, and promises a rich yield. The find is in a gorge near the Cayadutta creek, close to the great falls. Experts from Bradford, Pennsylvania, have assisted in the work, and they say that the rock strata and the lay of the land are similar to those of some of the best yielding wells in Pennsylvania. Natural gas was once struck in this vicinity by John E. Wells while sinking a well for water near the old fort built by Sir William Johnson. The gas flowed for some time, but the well was never developed.

The M. C. Bullock Manufacturing Co., Chicago, Ill. (Corliss engines, band friction hoisting machinery, diamond-pointed rock drills for exploring purposes, and general mining machinery), write us: We are extremely busy in every department, having worked overtime the past six months, and in December found it necessary to put on full double shifts, running night and day. Have made many important additions to our plant, such as lathes, planers, slotters, boring machines, drill presses, punch and shears, etc. Our orders have covered a wide range of work, among them several 75-ton Boyle ice machines, a large number of Lane's band friction hoists, ranging from 2 feet to 21 feet diameter, heavy Cornish pumps, rope haulage plants for mines, compound Corliss air compressors, our new patent slide valve Corliss engines, Murphy champion mine ventilators, rock drills, well boring drills, and a large number of our patent diamond-pointed rock drills for prospecting. Among notable foreign orders are diamond drills for Mexico, South Africa, South America, England, Holland, Servia, and hoisting machinery for several countries named; and we are now building a large first motion plant to wind 3,100 feet of 5" flat rope, with Lane's patent band friction drums, driven by a pair of tandem Bullock Corliss engines, 18 and 28"x48", to work under 150 pounds steam. The plant is to be erected in a tunnel, 2,500 feet from the boilers, and at an altitude of 15,000 feet above the sea, in one of the largest silver mines in Bolivia, where coal costs $50 per ton. Our business has increased so rapidly that we find it necessary to enlarge our plant, build a new smith shop 120 feet long, an erecting room, 80x160 feet, fitted with overhead traveling cranes, and a foundry 200x60 feet, also fitted with traveling cranes. We take pleasure in crediting your paper with many inquiries that have led to valuable orders.

Machinists' Supplies and Iron.

NEW YORK, Feb. 1, 1890.

Iron—American Pig.—The demand continues very moderate, and there is a disposition shown to shade prices somewhat from the regular quotations, especially by holders of others than standard brands. We quote No. 1 X Foundry, $19.50 to $20; No. 2, $18.50 to $19. There is little activity in Grey Forge, which is quoted at $17.50 to $18.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Mechanical draftsman wants situation. L. N., AMERICAN MACHINIST.

Foundry foreman, 25 years' experience, is open for engagement. Address "Iron," AMERICAN MACHINIST.

Foreman boiler maker would like to make a change. 25 y'rs exp. Have refs. F. B., AM. MACH.

Wanted—Position as foreman of foundry or mach. shop. Thoroughly competent. W. H. S., AM. MACH.

Wanted—Three or four exp'd mech. draftsmen. Address Mechanical Engineer, P. R. R., Altoona, Pa., stating experience, also salary required.

Foreman and contractor wanted, who can handle men and do good work promptly. Address Steam Engine, care AMERICAN MACHINIST.

Wanted—One good draftsman to make machine shop drawings. State experience, also salary expected. Address Kenney & Co., Scottdale, Pa.

A situation wanted by a practical boiler maker, sober and steady man; do any kind of boiler work. Can give good refs. Address J. C., AM. MACHINIST.

Mechanical draftsman(23) with 2 y'rs practical exp. graduated at a German technical college, wants position. Salary moderate. BOX 78, AM. MACHINIST.

Wanted—Exp'd mech. draftsman for machine shop, capable of designing. Steady work and advancement for good man. P. O. B. 1,815, N. Y.

Machinists Wanted—First-class vise and machine hands of good habits, can find steady employment and liberal wages Address Morgan Engineering Company, Alliance, Ohio.

Wanted—Experienced draftsman on hoisting and mining machinery Good wages and permanent situation. State age, experience, and salary desired. Address "Pitts," AMERICAN MACHINIST.

Position wanted by an expert and reliable tool maker; capable of taking charge of tool-room. Good reference from last employer. Geo. D. Dawson, 31 Wentworth st., Charleston, S. C.

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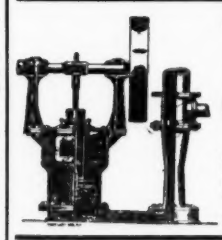

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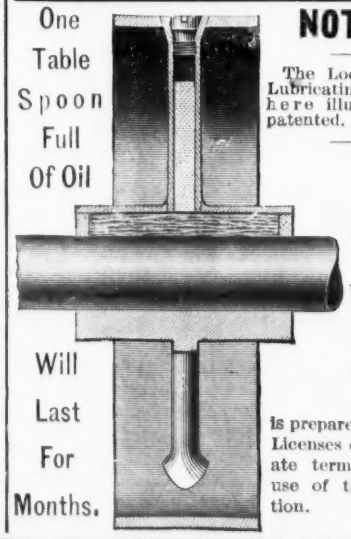

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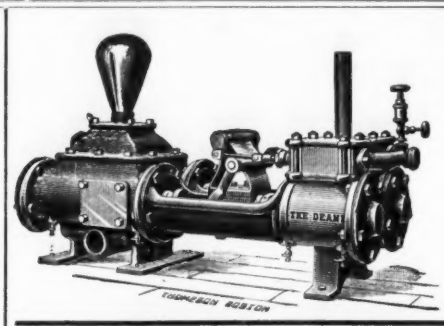

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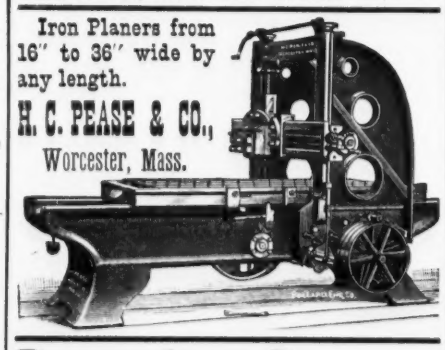

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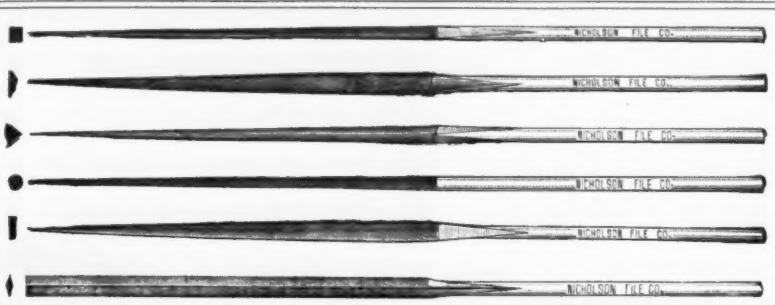

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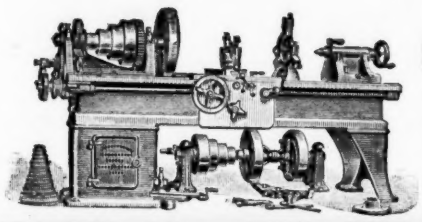

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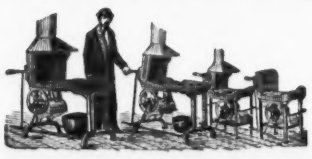

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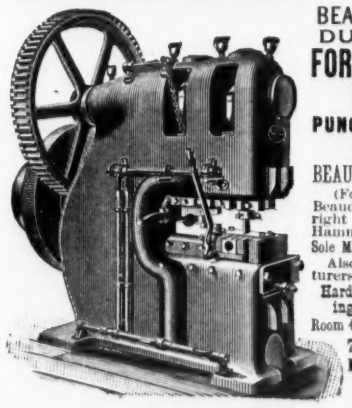

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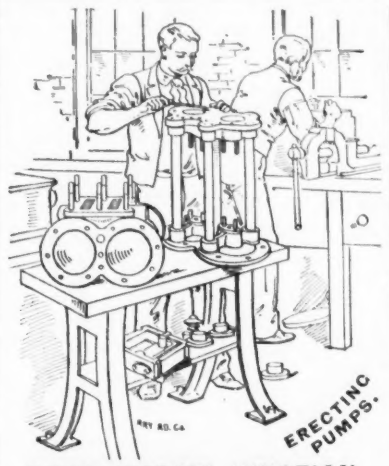

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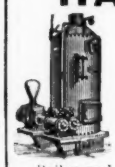

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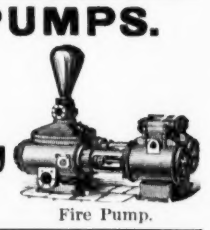

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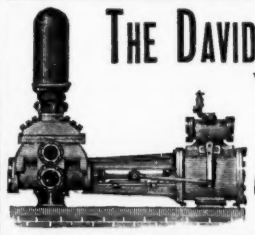

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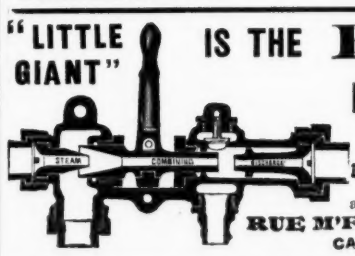

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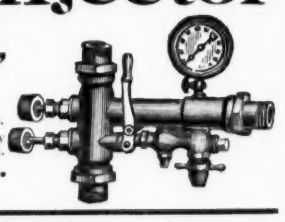

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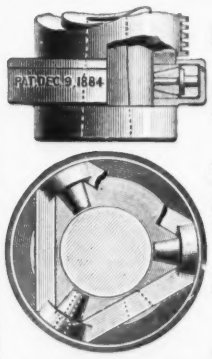

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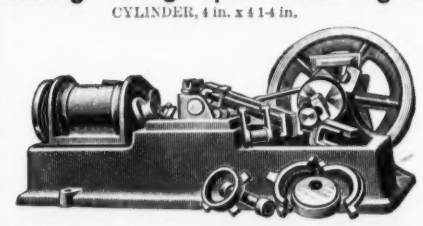

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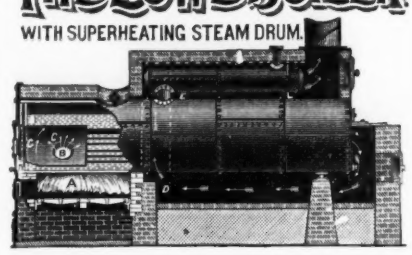

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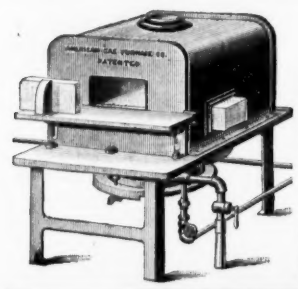

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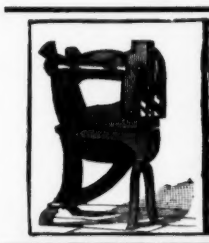

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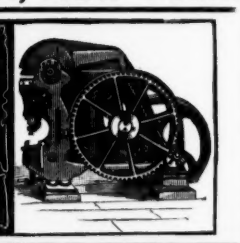

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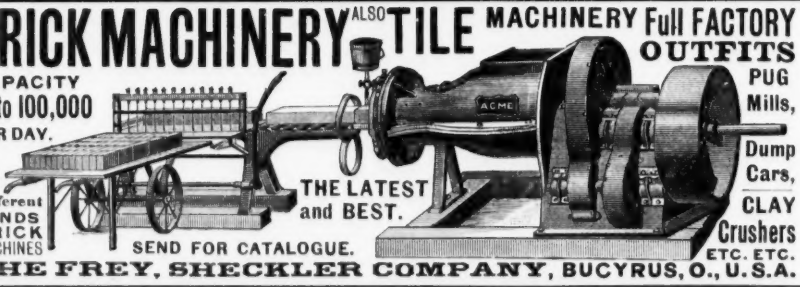

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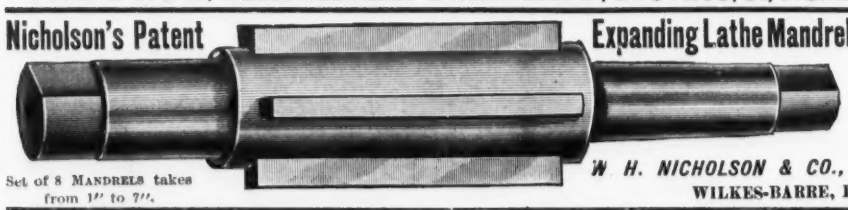

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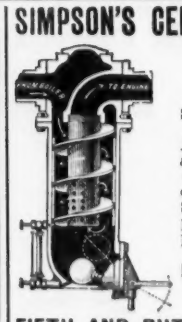

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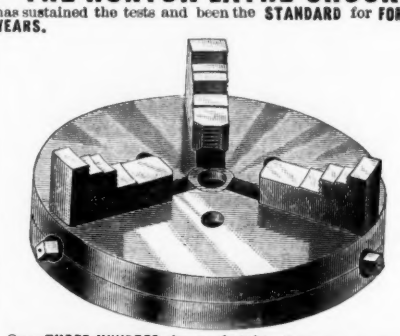

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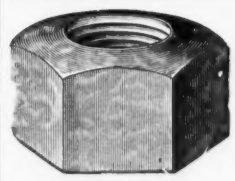

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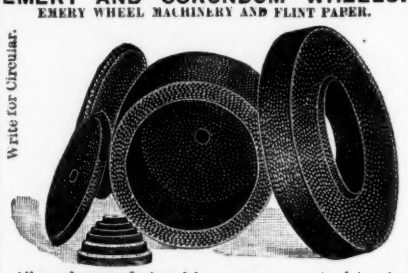

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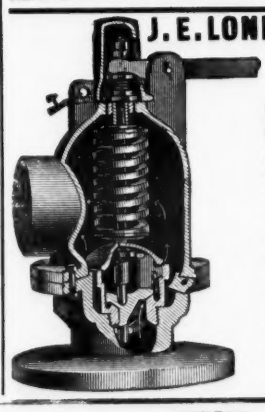

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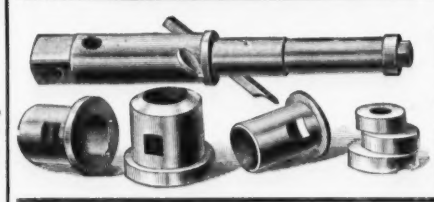

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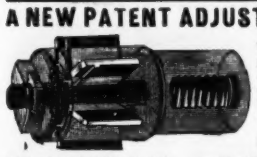

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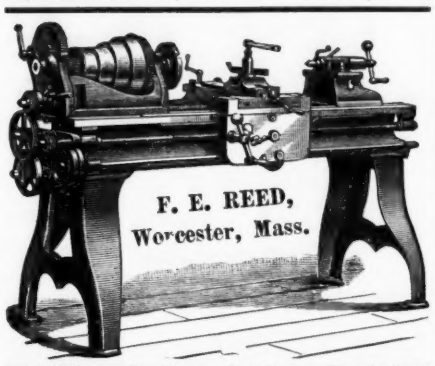

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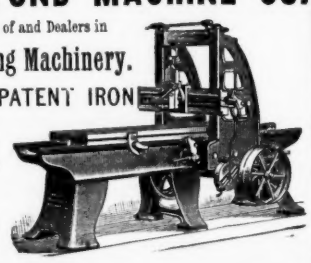

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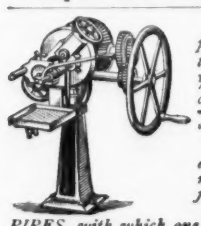

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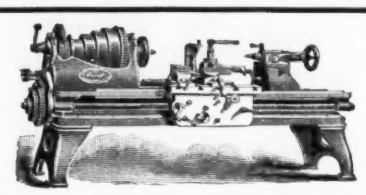

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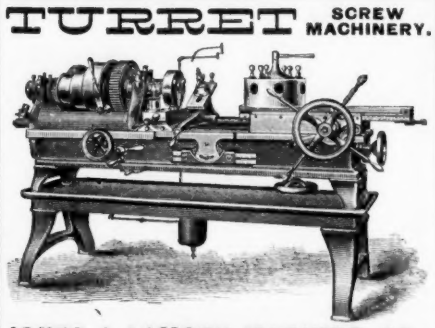

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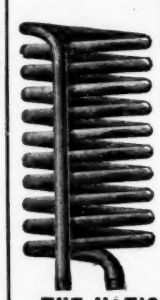

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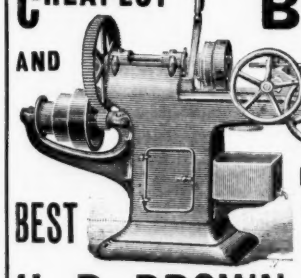

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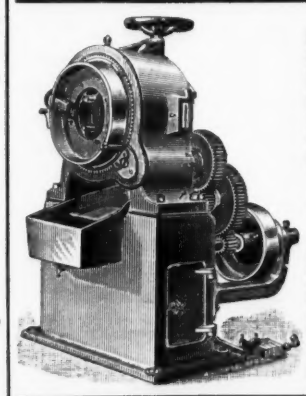

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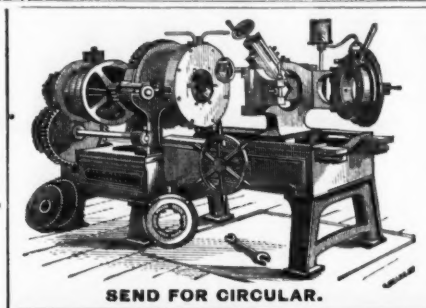

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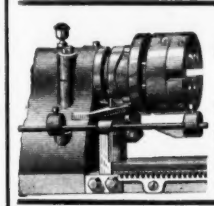

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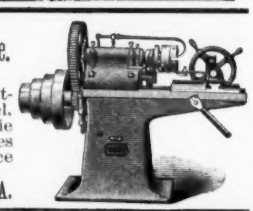

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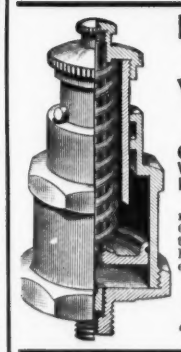

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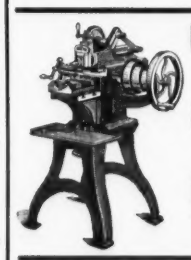

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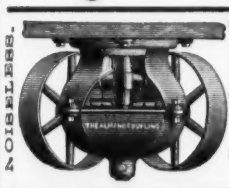

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SURE GRIP STEEL TACKLE BLOCK.

HALF THE COST of hoisting saved to Machinists, Contractors, Butchers, Builders and others. Admitted to be the greatest improvement EVER made in Tackle Blocks. The cheapest in the market. *Write for Catalogue.*
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Our Steam Damper Regulator is the most perfect and simplest machine in the market. Price, $60 and $100. Any one can apply it. Send for circular to Mason Regulator Co., Boston.

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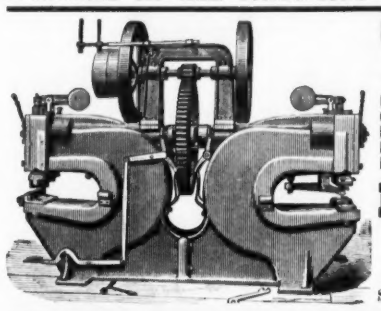
MACHINE TOOLS FOR WORKING IRON AND STEEL,
Improved TURNTABLES for LOCOMOTIVES, CARS and PIVOT BRIDGES.
High Speed Power Traveling Cranes and Hand or Power Swing Cranes, Shafting, Pulleys, Hangers, &c., for transmission of power. Improved Self-Adjusting Injector of 1876. Self-Acting Injector of 1887. Fixed-Nozzle Automatic Injector of 1885.
INJECTORS for ALL CONDITIONS of LOCOMOTIVE and STATIONARY SERVICE.



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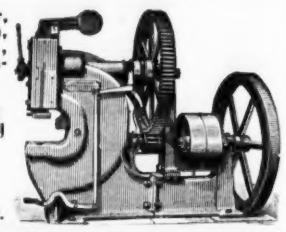

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Extra Heavy and Powerfully Geared Up.
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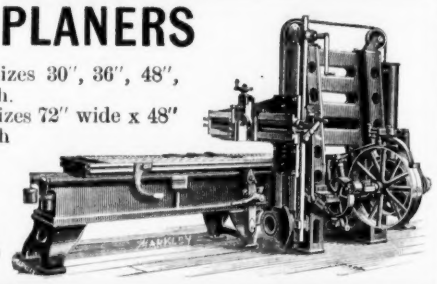

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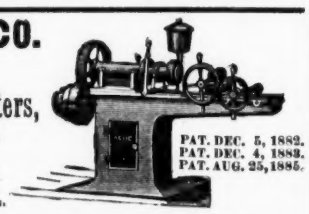

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TRAVERSE BORING MACHINES,
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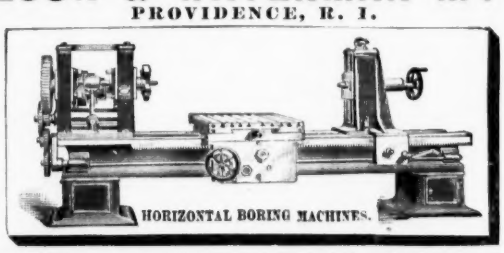
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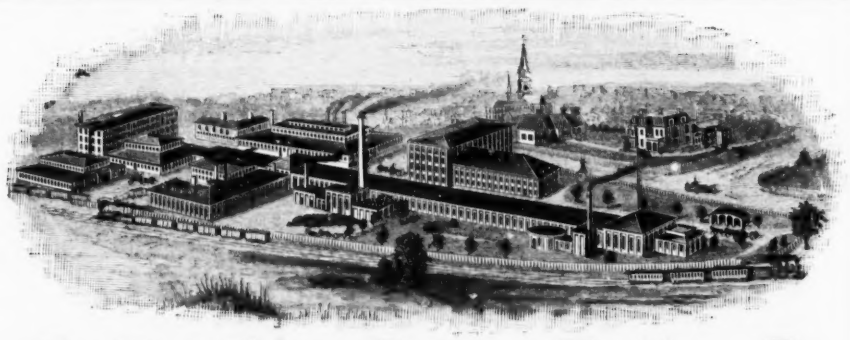

The Corliss Steam Engine Co.
PROVIDENCE, R.I.
Incorporated June, 1856; Established by
GEORGE H. CORLISS,
INVENTOR OF THE CELEBRATED
"CORLISS ENGINE."
DESIGNER & BUILDER OF THE FAMOUS
"CENTENNIAL ENGINE,"
Exhibited at the Philadelphia Exposition, 1876.

These works have been fully equipped, at great cost, with heavy special tools, of his invention, for them anufacture of this perfected engine, which is a guarantee of superiority in workmanship, and interchangeability of parts never before attempted in the line of steam machinery.

The public will understand that we have no relations with American or European builders of so-called "Improved Corliss Engines," and that the final and perfected Engine of Mr. George H. Corliss, embodying his latest ideas, is to be obtained exclusively at our works.

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Especially adapted for compound and triple expansion engines requiring superheated steam and at very high pressure.

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BUILDERS OF
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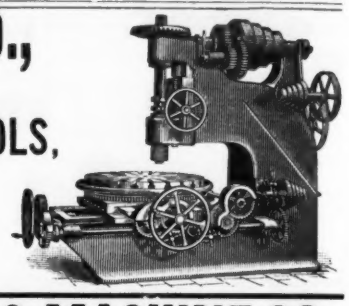

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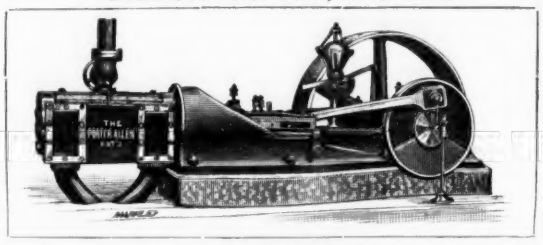

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HIGH ECONOMY. DURABILITY. CLOSE REGULATION.

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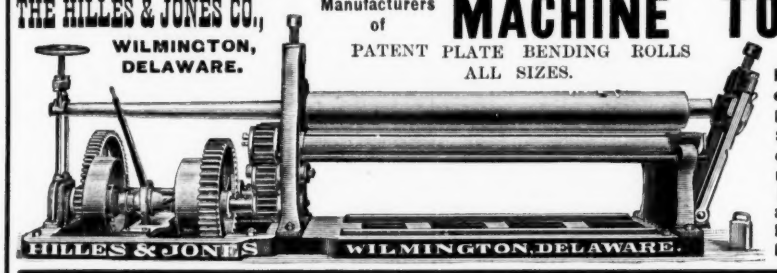

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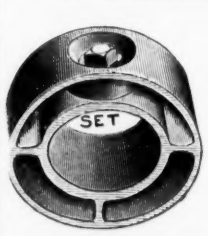

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MADE STRONG, LIGHT AND NEAT,
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425 MAIN STREET, SPRINGFIELD, MASS. J. H. BULLARD, MANAGER.
FORGING AND WELDING BY PETROLEUM AIR BLAST.
ALL OIL BELOW BURNERS! NO SMOKE, DIRT, OR ASHES!
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Los Angeles, Cal. ALDEN SPEARE'S SONS & CO., 3 Central Wharf, Boston. KALAMAZOO Feb. 5, 1889.
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A Cheap & Simple Steam Pump.
Working by direct action of steam. Has no valves or other working parts, and cannot get out of repair, cannot freeze, and will pump ashes, waste, or anything that can enter the pipes.
MADE IN LEAD OR BRASS FOR ACIDS.
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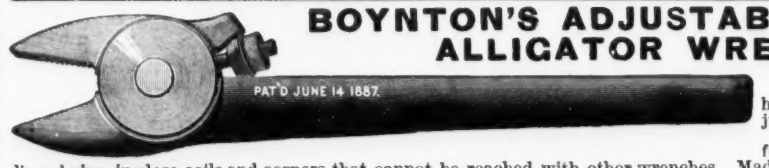

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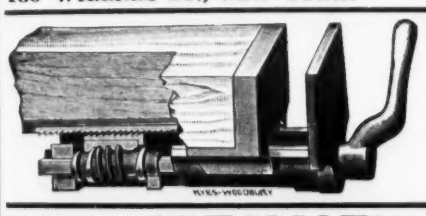

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BALL AUTOMATIC CUT-OFF ENGINES,
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The characteristics of these Engines are Beauty of Design, Superior Finish, Limited Feet in Space required, Economy of Fuel, Perfection of Regulation.
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In Use, Over 2,500. 25 to 1,000 H. P.

These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H. P. for driving Dynamo Machines *a especialty*. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail. **Address, BUCKEYE ENGINE CO., Salem, Ohio.**

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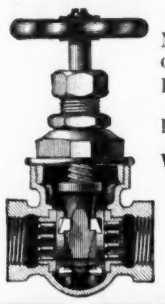
Sole Licensees and Manufacturers for New Jersey (South of Trenton), Eastern Pennsylvania, Delaware, Maryland and Virginia.

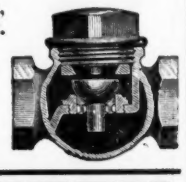
BLESSING'S RENEWABLE-SEAT GLOBE, STRAIGHTWAY and CHECK VALVES.



The Renewable-Seats and Disks are cast from the best Phosphor Bronze Metal, which has lasting qualities, double that of the best Steam Metal commonly used in first-class valves. The seats are simply screwed to place by the use of a special wrench furnished with each valve.

These valves are equally applicable to steam, water, or other fluid pressure.

We also manufacture **Blessing's Albany Steam Traps, Water Circulator and Purifier; and Pump Governor.**



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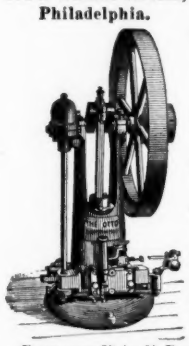

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Consume 25 to 75 Per Cent. Less Gas than ANY other Gas Engine doing the same work.

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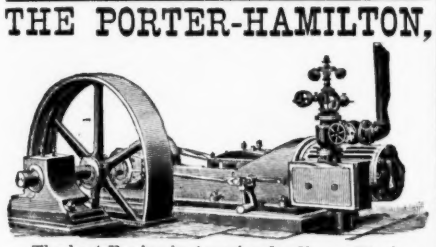

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Maker of all kinds of

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Special facilities for Accurate Work.

Bevel Gears cut theoretically Correct.

SEND FOR OUR LATE LIST OF NEW AND SECOND-HAND

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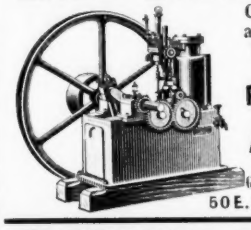

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RELIABLE AND ECONOMICAL.

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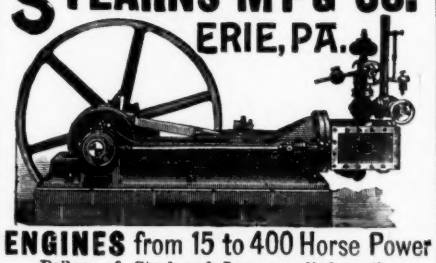

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BRAINARD MILLING MACHINES,

25 Different Styles and Sizes.

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NEW AND IMPROVED MILLING MACHINE.

☞ Note the following new features:

☞ Overhanging arm removed without taking off the sleeve.

☞ Sleeve for the overhanging arm and the column cast in one piece.

☞ All movements operated from front of machine instead of under the table.

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☞ Power feed entire length of table.

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☞ Indexed feeds on all machines.

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☞ Each machine furnished with a vise.

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THE WATTS, CAMPBELL CO.

MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.

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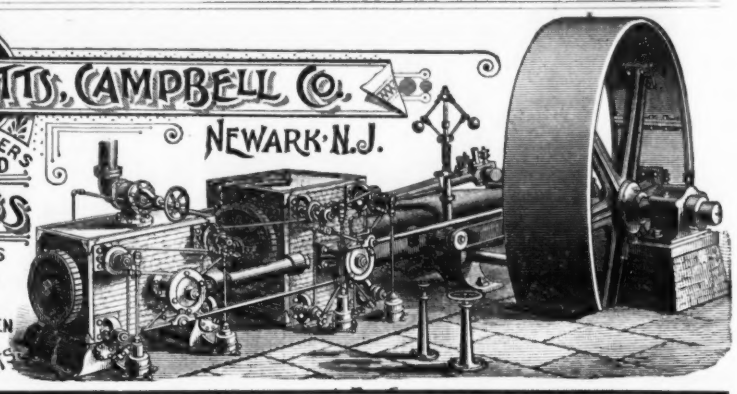

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NON-CONDENSING, CONDENSING COMPOUND. 40 TO 1,000 H.P.

Send for Circulars.

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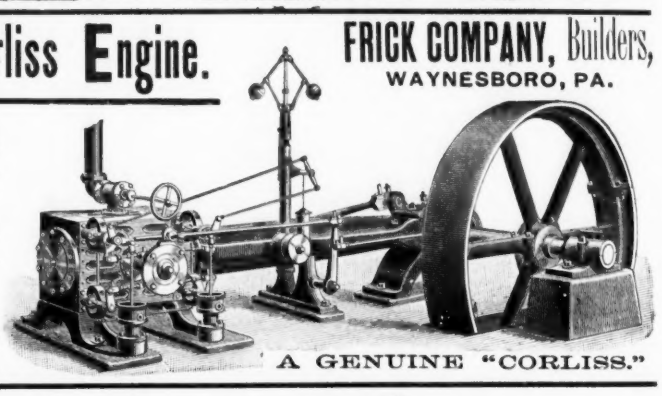
FRICK COMPANY, Builders, WAYNESBORO, PA.



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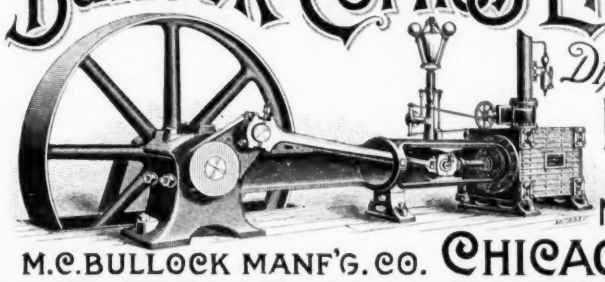
Bullock-Corliss Engines.



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NEW AND SECOND-HAND

MACHINERY.

FOR IMMEDIATE DELIVERY.

Engine Lathes,	14 in. x 6 ft.	Fitchburg,	new.
" "	15 in. x 8-8 ft.	Porter,	new.
" "	16 in. x 6 ft.	Fitchburg,	2nd hand A1.
" "	16 in. x 6 ft.	"	new.
" "	16 in. x 6 ft.	Wright,	new.
" "	16 in. x 8-8-10 ft.	Hendey	new.
" "	ditto, with tapers,	"	new.
" "	18 in. x 8-10 ft.	"	new.
" "	ditto, with tapers,	"	new.
" "	18 in. x 8 ft.	Fitchburg,	new.
" "	20 in. x 10 ft.	Wright,	new.
" "	21 in. x 8-10 ft.	Fitchburg,	2nd hand, A1.
" "	24 in. x 12 ft.	"	new.
" "	24 in. x 12 ft.	Wright,	new.
" "	24 in. x 12	Fitchburg,	2nd hand, A1.
" "	54 in. x 20 ft.	"	new.
" "	86 in. x 18 ft.	heavy pattern,	good order
Drills,	20 in. wheel feed	Prentice,	new.
"	21 in. " " Back gears,	"	new.
"	25 in. Self feed, Back gears,	"	new.
"	32 in. " " "	"	new.
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"	24 in. Friction	Hendey,	2nd hand, A1.
"	26 in. Rack,	Lodge, Davis,	new.
Planers,	24 in. x 24 in. x 6 ft.	Fitchburg,	new.
"	24 in. x 24 in. x 6 ft.	Lathe & Morse,	new.
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"	42 in. x 42 in. x 12 ft.	Fitchburg,	2nd hand, A1.
Screw Machines,	No. 1, Complete,	B. & S.	2nd hand, A1.
"	" 2, "	"	"
"	" 2, "	J. & L.	"
Turret Chucking Lathes,	15 in.	Hendey,	new.
"	" 20 in.	"	new.
Bolt and Pipe Cutter Combined	2 in.		new.
Horizontal Boring Mill,	12 ft. long,		2nd hand, A1.
Pulley Machine,	36 in.	Stevens,	2d hand, good.
Miller, heavy pattern,	12 in. x 4 ft.	Eynon,	new.
Bridge Riveter and Compressor,		Allen,	2nd hand.

Also full line of **BRIDGE AND BOILER TOOLS.**

Agent for HALSEY PORTABLE DRILLS, and FITCHBURG MACHINE WORKS.

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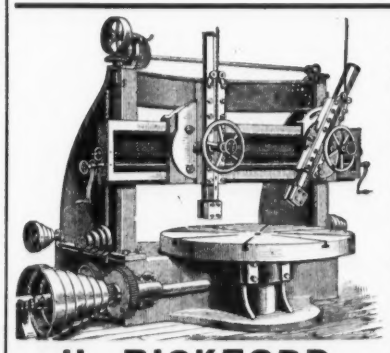

BORING AND TURNING MILLS, 4, 5 and 6 Ft. SWING.

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PATENTS THOMAS P. SIMPSON, Washington, D. C. No atty's fee until Patent obtained. Write for Inventor's Guide.

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Of Wood and Metal Workers without Steam Power, Equipped with Outfits of

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Foot Power Machin'y

allow lower bids on jobs, and greater profits than by any other means for doing work. Sold subject to trial in your shop. Send for Price List Catalogue.

W. F. & JNO. BARNES CO., Address 1995 Ruby St., ROCKFORD, ILL.

C. H. DE LAMATER & CO.

have closed their extensive manufactory at the **Foot of West 13th Street, New York,** and have sold the Hot Air Pumping Engine and Steam Pump business to the De Lamater Iron Works (incorporated in 1889), and the Propeller Wheel business to the Samuel L. Moore & Sons Co., of Elizabethport, New Jersey.

In order to close out the remainder of the stock, offer for sale

A Very Desirable Lot of Machinery,

such as lathes from 15" to 88" swing, planing machines 48"x45'x10', 53"x50"x12', 17"x14"x24', 72"x 69"x24', and various other sizes; drilling machines, slotting machines, shaping machines, boring machines, bolt cutting machines, cutting-off machines, nut tappers, milling machines, gear cutters, emery tool grinders, portable drills, screw-cutting machines, vises, lathe and planer tools, and a variety of small tools; also traveling and jib cranes.

Punching and shearing machines for boiler makers, with a general outfit of small tools. Blacksmiths' tools, such as anvils, sledges, tongs, etc. Pattern lathes, benches, saws, screws, nails, and a general supply of small tools. Foundry cranes, cupolas and small tools. Blocks, ropes, bolts, nuts, washers, packings, pipe and fittings, iron and brass valves. Boiler iron, steel plate and boiler rivets. Bar iron and steel, also steam hammers, and two 8"x16" and one 10"x20" Rider cut-off engines.

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For Pattern Makers' Use.

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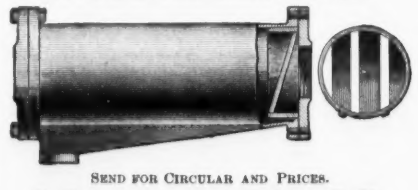

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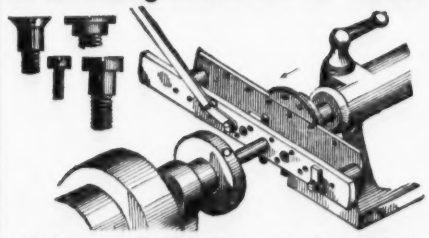

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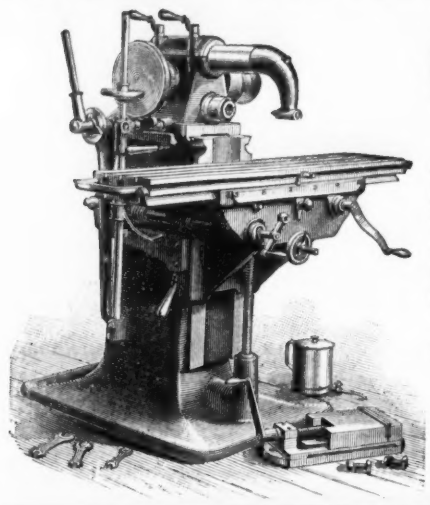

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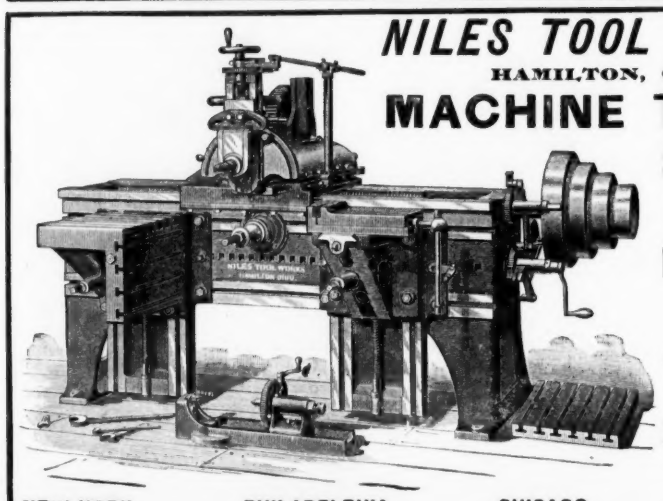

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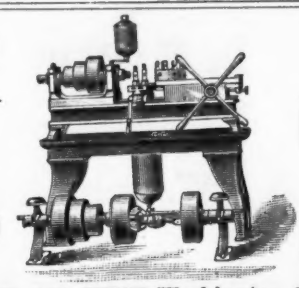

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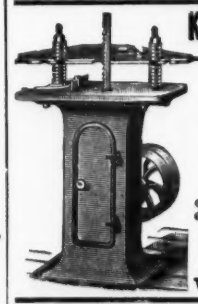

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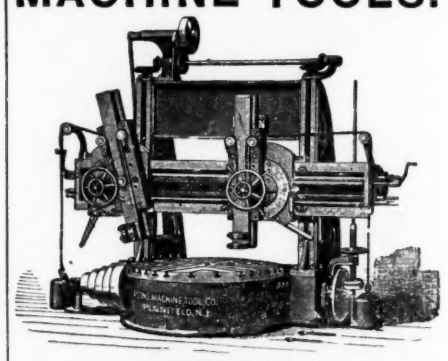

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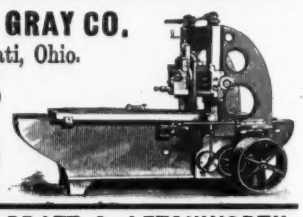

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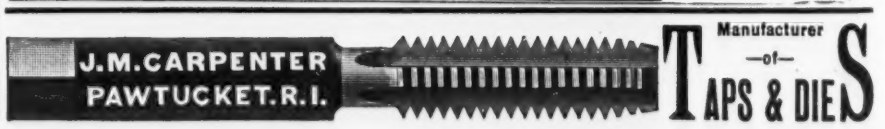
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